MACHINERY.

November, 1904.

A REVIEW OF STEAM TURBINE PATENTS.—2.

Hoehl, Brakell & Gunther, 1863.

The turbine produced by this aggregation of inventors has as its only novelty an arrangement of passages by which the steam returns on itself and so is utilized twice by the same wheel, although an additional set of wheel blades is required.

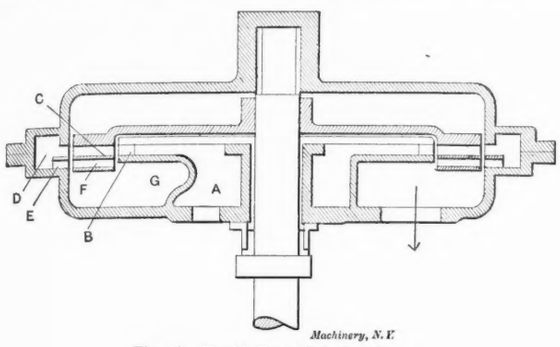

Fig. 19. Hoehl, Brakell & Gunther.

Steam enters the chamber *A*, passes radially outward through the guide passages *B* to the wheel blades *C*, then discharges into the annular chamber *D*, where its motion is reversed, and escapes through *E* to another set of buckets *F*, and finally to the exhaust chamber *G*.

Perrigault & Farcot.

The type of turbine here exemplified is in principle like Wilson's turbine, in Fig. 13 of the September number, the latest representative of which is found in the compound turbine of Messrs. Riedler and Stumpf, to which reference will be made later. The inventions of Perrigault & Farcot took several forms, but the general principle is well illustrated by Fig. 20 herewith. Here steam enters through the pipe or nozzle *A* and impinges against the wheel buckets, passing through the other side of the wheel where it discharges into pipe *B*. This pipe brings the steam around

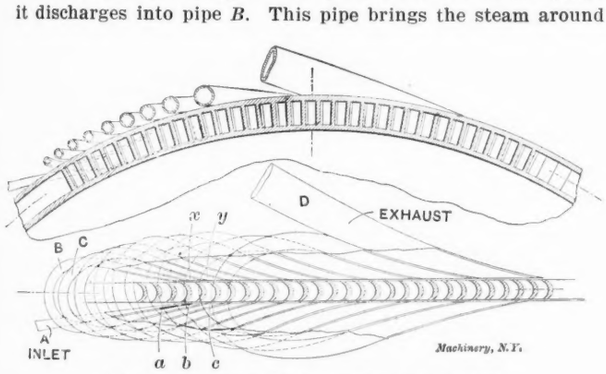

Fig. 20. Compound Turbine with only one Wheel.

again to the inlet side of the wheel, allowing it to discharge a second time against the buckets of the same wheel, when it is again picked up by a second pipe *C* and so on. The exhaust is finally through pipe *D*.

The arrangement consists essentially in a bundle of bent pipes having openings *a*, *b*, *c*, through which the steam impinges against the wheel buckets; and openings on the other side, *x*, *y*, etc., which gather up the steam flowing from the wheel and bring it round again to the inlet side. The object is to utilize the steam over and over without necessitating a series of rotating wheels. It is a system that has been tried with various modifications, but without much success. Its obvious disadvantages are: Large losses from friction and leakage, and the wide range of temperatures through which the same buckets must pass, thus causing condensation and re-evaporation as in the steam engine.

Hannsen, 1870.

Among the most successful types of turbine is that having a succession of chambers in each of which is a single impulse wheel. There is only a slight drop in pressure from chamber to chamber, so that the velocity of the steam does not become excessively high at any point. The latest turbine of this description is the Hamilton-Holzwarth, built by the Hoovens,

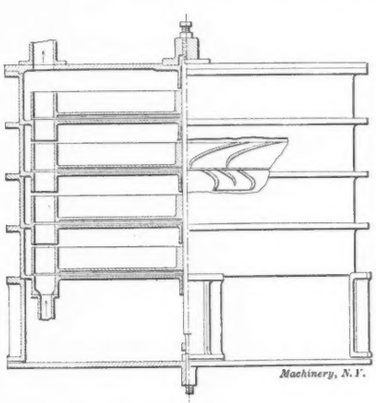

Fig. 21. Compound Impulse Turbine.

Owens, Rentschler Co., Hamilton, O., and the earliest one of which there is any record is the invention of Real & Pichon, 1827—the first patent referred to in this series. The invention of Hannsen, shown in Fig. 21, is almost precisely the same, except in regard to structural features. This is a vertical turbine, steam entering at the bottom and rising to the top.

Moorhouse, 1877.

Of far greater importance, however, is the patent of James Moorhouse for a turbine on the same plan. As shown in Fig. 22 *a*, *a*, *a*, etc., are the nozzles, and *b*, *b*, *b*, etc., the wheel buckets. Steam flows radially outward at each wheel until near the exhaust end, where there is a different arrangement owing to a smaller drop in pressure between the successive chambers.

Moorhouse realized what previous inventors of this type of

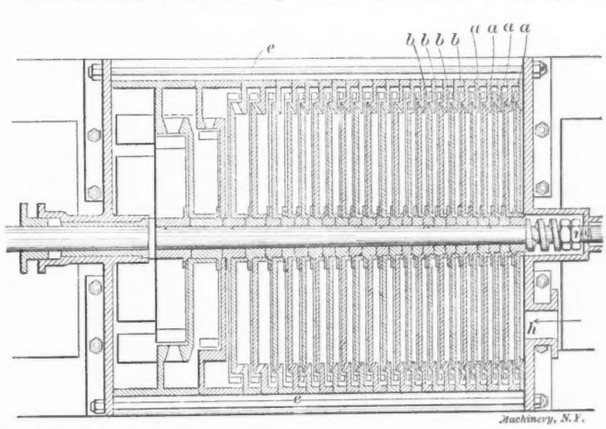

Fig. 22. Compound Impulse Turbine, with provision for Expansion of the Steam.

compound impulse turbine had not, or at least had failed to specify, namely, that provision must be made for progressive expansion of the steam by a gradual increase in the area of the steam passages. His patent is a broad one and fully covers this requirement as a general principle, apart from the

exact method used in its application. In his specifications he says that his invention consists of a cylinder built in sections, each section composing a separate compartment. Through the center of the cylinder passes a revolving driving shaft upon which is fitted a series of turbine wheels, each having, at or near its circumference, a sufficient number of buckets. These wheels are as many in number as the compartments into which the cylinder is divided. Each compartment contains a turbine wheel, and is separated from the adjoining compartment by means of a dividing plate or diaphragm. The foregoing is condensed from his specifications but correctly represents their meaning. He then goes on to say:

"Openings are made in the dividing plates which separate each compartment from the adjoining ones, and the area of these openings is proportioned to the pressure of the steam or other driving fluid, and to the number of compartments and turbine wheels, and to the extent to which it is desired that the driving fluid should be expanded before being finally discharged from the engine. By this means the driving fluid, admitted at its highest pressure into the smallest compartment, passes into the second compartment through openings of such area that it expands to a calculated extent. The same process is repeated, etc."

He says that various forms of turbine may be used, and his first claim is as follows:

"In combination with a rotary engine, the dividing plates between the compartments provided with openings forming communications respectively of varying area between said compartments, the turbine wheels in such compartments, and a driving shaft, substantially as and for the purpose set forth."

Cutler, 1879.

This is a radial outward flow turbine in which the compound principle is used. Steam enters at the bottom, passes to the center and then flows radially outward through the passages between the guides *c c c* and the wheel vanes *d d d*. The rotating wheel *A* has vanes attached to each of its two

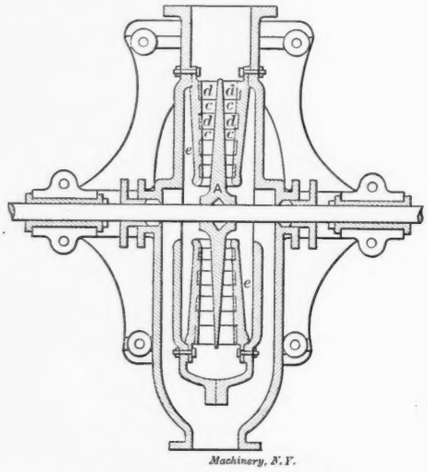

Fig. 23. Radial Outward-flow Turbine.

faces so the pressure is balanced on each side. Expansion of the steam is allowed for in part by the increasing width of the passages and in part by the fact that the steam is constantly flowing from a smaller to a larger diameter of wheel, so that the circumferential area of the passages constantly increases from this cause as well.

Imray, 1881.

This is another attempt to apply the compound principle to a single wheel, having a single set of vanes, but differs somewhat from the turbines of Wilson and Perrigault and Farcot. Steam enters at *A*, passes through the nozzle and impinges against the buckets *C C C*. These buckets are semi-circular in shape, as indicated in the sectional view in the upper left-hand corner of the illustration. The steam enters at one side of the bucket, follows the curved surface of the bucket, and discharges into the opposite side of a semi-circular stationary bucket or guide *D*. Here the direction of flow of the steam is again reversed. The steam, as before, flows around the stationary guide surface and discharges against one of the buckets *C*, whence it is carried along to the second stationary bucket, and so on, alternately entering the successive wheel buckets *C C C* and the successive stationary buckets *D D D*. It finally discharges on the opposite side of the turbine casing, at *E*. In the meantime steam enters at *A* on the

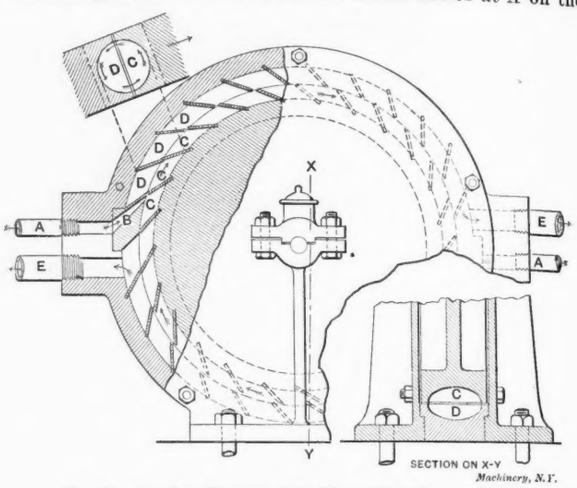

Fig. 24. Another Compound Turbine with only one Wheel.

right-hand side of the casing and zigzags through the lower half of the wheel in a similar manner, exhausting at *E* on the left-hand side.

De Laval, 1883.

The first patent of this noted inventor was for a reaction turbine and was taken out in 1883, in several countries. As it was illustrated in the De Laval article in the last number the cut is not reproduced herewith. According to the specifications, steam (or other fluid) enters the wheel at the center through a nozzle, and passes outward through hollow curved arms, escaping at their ends, and causing the wheel to rotate at high velocity. The wheel shaft drives another shaft at a slower speed, by means of friction wheels, the requisite pressure between the friction surfaces being obtained by the axial thrust of the turbine wheel. The principle of this turbine is no different from that of the first American patent by Avery in 1831, but its application to centrifugal cream separators, for the extensive development of which Dr. De Laval has been responsible, was successful and marks the beginning of an important career by this inventor in the manufacture of steam turbines.

Babbitt, 1884.

B. T. Babbitt, besides acquiring fame as a manufacturer of laundry soap, was both an inventor and a mechanic, and one of his inventions related to a steam turbine of the type shown in Fig. 25. This is an inward-flow turbine with two wheels,

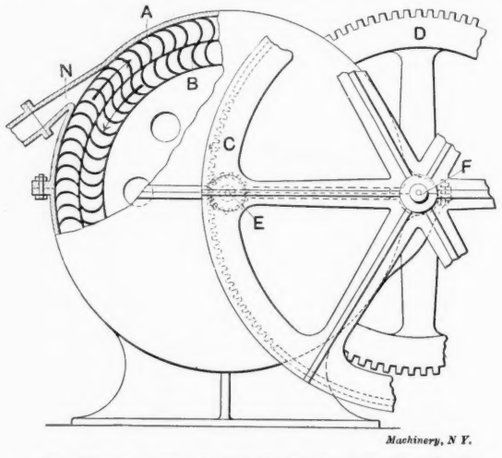

Fig. 25. Two Wheels Rotating in Opposite Directions.

A and *B*, having rows of buckets on their peripheries. The wheels rotate in opposite directions. The steam from the nozzle *N* impinges against the buckets of the outer wheel, which it is supposed to leave with a considerable residual

velocity, and gives up its remaining energy to the buckets of the inner wheel. The chief novelty of the invention is the method of transmitting power from these two wheels to the slow speed shaft *F*. The turbine wheels are mounted concentrically on two separate shafts, one end of which is shown at *E*. There is a pinion on the outer end of each of the shafts. One of these pinions gears with the internal gear *C* on one end of the slow speed shaft *F*, and the other pinion gears with the spur wheel *D* on the other end of shaft *F*.

Isaac Last, 1885.

This is another example where the steam is caused to return upon itself, first flowing radially outward then reversing and flowing radially inward, just as in the Hoehl, Brakell &

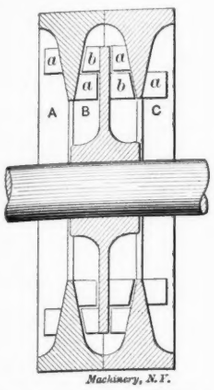

Fig. 26. Combined Inward and Outward Flow.

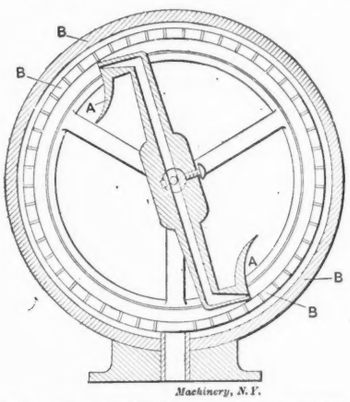

Fig. 29. Denke's Modification of the Reaction Wheel.

Gunther turbine, Fig. 19. In the Cutler turbine, however, compounding is carried further than in the former, there being a series of wheels placed side by side on the same shaft. In the sketch, *A B C* are the different chambers in which the wheels rotate; *a a* are the guides for directing the steam against the wheel buckets and *b b* are the wheel buckets. One drawing in the patent specifications of Last has a very modern appearance, in that he shows a compound turbine built up of two parts, the high pressure and the low pressure, in each of which is a series of compound wheels like that shown in Fig. 26. The high-pressure and low-pressure sections are connected by a pipe, and their arrangement resembles that of some of the turbines built to-day.

Parsons, 1885.

With a patent issued in several countries in this year, the Hon. C. A. Parsons, who was the first to place the turbine on a commercial basis, enters the field. In all his work he has adhered to the reaction turbine and is responsible for the successful development of the compound reaction motor. In Fig.

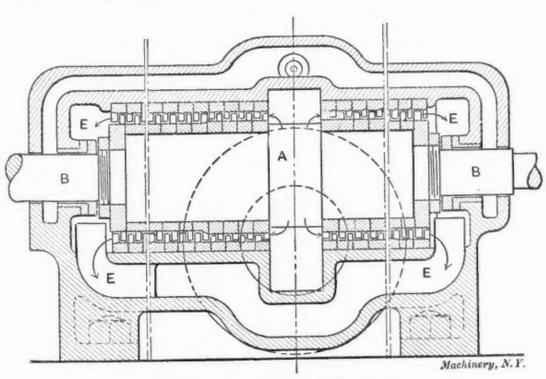

Fig. 27. Parsons' First Turbine.

27 is a section of one of his patent drawings. Steam enters at the center *A*, and passes right and left between the series of guide vanes attached to the outer casing and the rotating blades attached to the inner drum, which rotates on shaft *B B*. Steam escapes to the exhaust passages *E E* and finally to the exhaust pipe shown by dotted lines. The following paragraphs are extracts from his description:

"I arrange the portions of the motor to form an approximately cylindrical figure, the whole being mounted upon the same shaft, the first delivering into the second, the second into the third and so on. Each portion comprises a set of fixed and a set of moving vanes, the direction of motion of the actuating fluid being generally parallel, or approximately so. To balance the end pressure upon the cylinder, I mount two similar sets of rotary parts upon one shaft, one set being so placed at each side of the inlet for the actuating fluid that the entering stream divides right and left, and the exhaust takes place at both ends.

"As the speed of the motor will be necessarily high, and perfect balancing of the moving parts would not be practicable, I give to the bearings a certain very small amount of elasticity or play combined with a frictional resistance to their motion."

This refers to the well-known Parsons construction shown in Fig. 28, in which there is an annular space, between the shell of the bearing and the pocket for the shell bored out in the frame, filled with a series of metal rings. Every other ring is bored to fit the outside of the shell, but its outside diameter is smaller than the bore of the pocket, as in *a a*. The alternate rings *b b* are turned to fit the pocket, but are bored larger than the outside of the shell. The rings are forced together by a spring *s*, so that they offer considerable resistance to any lateral movement of the bearing.

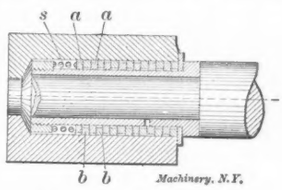

Fig. 28. Bearing of Parsons' Turbine.

He says: "The lubrication is effected by forcing lubricant through pipes to the parts to be lubricated and for this purpose a pump can be employed. To prevent leakage past the shaft at the end covers of the casing, which, when steam is the actuating fluid, would be inconvenient, I form annular recesses in the covers around the shaft ends, and place these recesses in communication with a pipe in which a partial vacuum is maintained by suitable means, such as a steam jet."

In the next year, 1888, Parsons took out a patent in which the turbine wheels are arranged in groups, each successive group being of larger diameter than the preceding one, to allow the steam, as it expands, to flow through larger spaces, as required by the increase in the specific volume of the steam. He also proposes to secure steam-tight joints at the bearings by admitting water under pressure to an annular groove passing around the bearing. He suggests cutting a spiral groove on the shaft, at the section where this annular groove occurs, with the idea that when the shaft is revolving at high speed, the spiral will diminish the quantity of water forced into the turbine casing by the air pressure, when the turbine is running condensing.

A. Denke, 1890.

A simple and interesting though inefficient scheme for taking advantage of the residual velocity of the steam as it leaves the nozzles of a reaction turbine of the Hero type was invented by A. Denke and is shown in Fig. 29. There are two diametrically opposite hollow arms rotating in a casing, on the inner periphery of which is a series of vanes marked *B B*. The ends of the arms are bent at right angles, forming nozzles, and the steam which enters at the center flows radially outward and escapes from the nozzles in a tangential direction. The steam impinges against the stationary vanes of the casing and its direction is reversed so that it flows radially inward and strikes the curved horns *A A* attached to the ends of the rotating arms. A simple reaction wheel of this type does not make a practical device because of the high speed at which it must necessarily rotate; but the arrangement shown might possibly be so designed as to somewhat improve the operation of such a wheel.

Altham, 1892.

A compound turbine consisting of two rotating wheels, one inside of and concentric with the other, is the invention of George J. Altham. The buckets of the inner wheel are arranged in its outer periphery and those of the outer wheel in its inner periphery, so that steam will act alternately on the inner and outer wheel, and successively on the different buckets of both wheels, the arrangement being such that the wheels rotate simultaneously in opposite directions. Fig. 30 shows at

the left a cross-section of the rims of the two wheels in which the buckets are cut. The other sketches show longitudinal sections of the rims. Steam is discharged from the nozzle into one row of buckets of the outer wheel, whence it passes to the first row of buckets of the inner wheel, thence to the second row of the outer wheel and finally to the last row of the inner wheel, from which it discharges into the turbine casing. In the smallest sketch, Fig. 30, the construction is indicated where

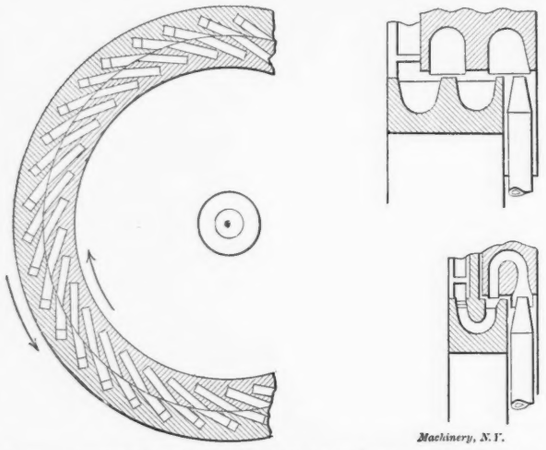

Fig. 30. Compound; two Wheels Rotating in Opposite Directions; no Guide Vanes.

there is only a single row of buckets in each wheel. The course of the steam in this turbine is similar to that in the Imray turbine, 1881, except that in the latter the outer set of buckets is stationary instead of rotary.

Dow, 1893.

When turbines first began to come into prominence in this country the one invented by J. H. Dow was one of the three or four that were most frequently mentioned. His first patent was issued in 1887, and later several others were taken out, but the one showing the most completely worked out design was issued in 1893. All of the Dow turbines are of the radial

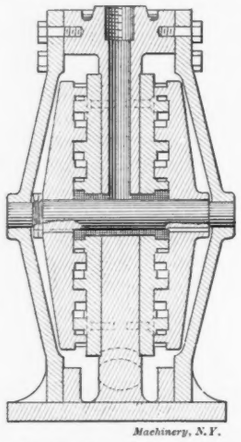

Fig. 31 Section of Original Dow Turbine.

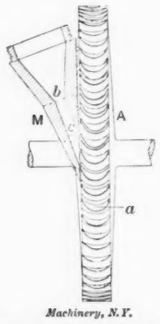

Fig. 34. De Laval Expansion Nozzle.

outward-flow type, consisting of alternating rings of rotating stationary vanes, and in this respect resemble one of Wilson's inventions of 1848. In Fig. 32, taken from his latest patent, *A* is the ring of stationary vanes directing the steam against the ring of rotating blades *B*, and *C* is another ring of stationary vanes, *D* a ring of rotating blades, etc. A peculiarity of his turbines is that the stationary vanes are not curved at their inlet ends in a way to guide the steam into them in the direction in which it leaves the rotating blades, except as the latter might be designed so that steam would leave them in the direction in which the wheel is turning, which would be an inefficient arrangement. In the patent of 1887 there is a single shaft on which are two disks facing each other, having annular rows of vanes cut on their inner faces. Between these two disks is a central stationary disk with annular rows of guide vanes cut on each of its faces. The arrangement is shown in Fig. 31. Steam enters at the center, and flows radially outward between the vanes on each side of the central disk. In his latest patent Dow compounds his turbine still further by providing several rotating and stationary disks ranged along the shaft on each side of the center. Steam enters at the center and gradually works outward toward both ends of the turbine. In his compound turbine he also uses a pair of disks at the center, so designed that they serve as pressure balances and hold the shaft and wheels in an endwise direction.

Parsons, 1893.

In this year Parsons took out a patent on a compound reaction wheel shown in Fig. 33. This is exactly similar in principle to the one already illustrated, invented by Monson in 1862. Later, in 1867, one of the same type was patented by T.

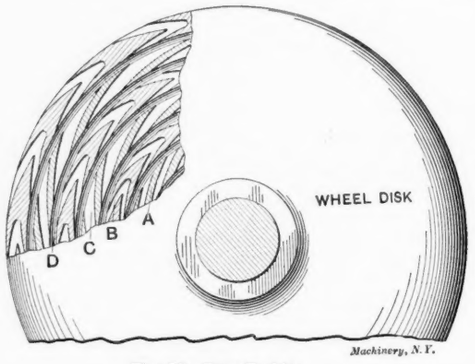

Fig. 32. Dow Turbine.

Banta. This patent of Parsons, therefore, is merely a construction patent and does not cover any principle not previously patented. Steam enters in the steam chest, at the left, passes through the hollow shaft to the first pair of arms, where it flows radially outward, then escapes, through openings at their extremities, into the first chamber. It then passes through a sleeve encompassing the shaft to the second pair of arms, and so on to the end of the turbine. The chief difference between Parsons' and Monson's is the shape of the arms, which Monson made curved and Parsons straight, and the arrangement of the steam channels through which steam passes from one chamber to the next. At one time or another Parsons has patented most of the feasible arrangements for a compound turbine. In 1890 he secured a patent similar in principle to the one issued to Moorhouse in 1877 except that he arranged to have the steam flow radially inward at each wheel and used the reaction principle. In 1891 he secured a patent for a reaction turbine consisting of a series of disks upon the same shaft

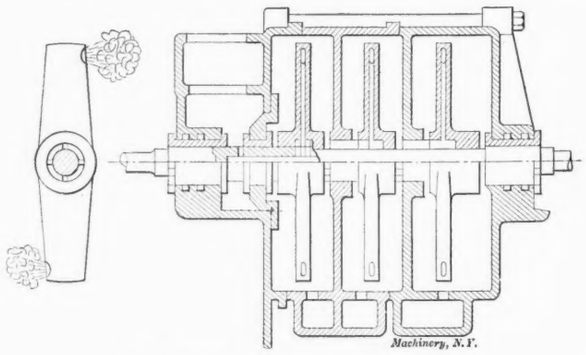

Fig. 33. Parsons Compound Reaction Turbine.

on the faces of which were several rings of blades. The steam flowed radially outward between these vanes instead of passing longitudinally through the turbine, as in the case of his earlier patent.

De Laval, 1894.

De Laval's most important patent relates to his expanding nozzle, in combination with a turbine wheel. It is interesting to note in this connection that the expanding nozzle was patented in this country in 1867, patent 64,539, for steam injectors. De Laval, however, was the first to apply the prin-

ciple of a diverging nozzle for the expansion of steam to a turbine. The two broadest claims of the patent are the following:

1. The combination with a bucket or turbine wheel, of a stationary nozzle opening adjacent to the wheel and having its bore diverging or increasing in area of cross section toward its discharge end, whereby the elastic fluid under pressure is expanded in passing through the diverging nozzle and its pressure is converted into velocity before the jet is delivered against the wheel.

2. The combination with a bucket or turbine wheel, of a stationary nozzle opening adjacent to the wheel and provided with a contracted receiving portion and with a discharge portion having its bore diverging or increasing in area or cross section toward its discharge end.

Maison Breguet, 1894.

Judging from the illustration accompanying this patent, it introduces no new principle that was not included in the invention of Hartman's compound impulse turbine, the patent for which was taken out in 1858. That is to say, the illustration shows a converging nozzle in connection with rotating rings of blades alternating with stationary vanes. This is nothing more or less than what is shown in Hartman's patent drawings. From the way the text of the Breguet patent reads, however, the inventor apparently had in mind the improvement of the De Laval turbine, and if such is the case he evidently intended to imply the use of a diverging nozzle instead of a converging nozzle in connection with a compound turbine. Putting this interpretation upon the patent it is of importance as the first to be issued upon this combination of elements, preceding, as it does, the Curtis patent (which introduced the same principle) by about two years. The description of the invention states that in the De Laval turbine "Even with a circumferential velocity of the turbine of 420 meters, if the steam has a velocity of 1,100 meters, it still discharges from this turbine with a velocity of 440 meters, and this velocity is much higher when the circumferential velocity of the turbine is less. The idea that has naturally come to us is to utilize anew this lost velocity in a second turbine mounted on the same axis, and even in exceptional cases in a third, so as to increase the use of the turbine. We affirm as our property the invention of the compound steam or gas turbine, in which the steam, or gas, after having lost a part of its live force in the turbine buckets, finally loses the remainder in the buckets of one or of several other disks mounted on the same arbor."

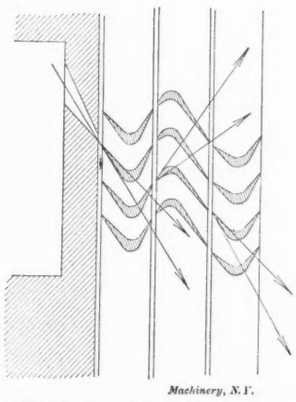

Fig. 35. Patent issued to the firm Breguet.

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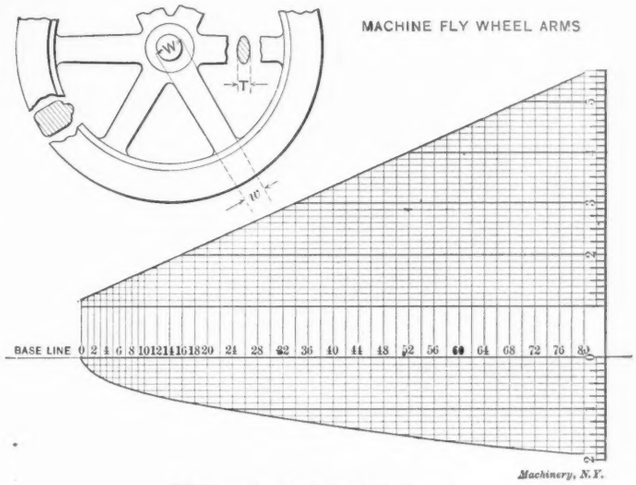
DATA SHEET FOR NOVEMBER.

The data sheet issued with the engineering edition for this month forms another practical supplement giving the results of the experience of several practical men. It contains some more matter upon gear wheels and pulleys, by Mr. Renkin, who has furnished material for the two preceding sheets upon the subject of gear wheels; and in addition gives the proportions for sheave wheels designed for both wire cables and manila rope. Also proportions for machine flywheels or handwheels.

Previous data upon the proportions of handwheels have been issued in the supplements to the November, 1902, and January, 1904, issues of MACHINERY.

We also have on hand another sheet upon the same subject, contributed by W. H. Raeburn, Dundas, Canada. As there is not room to use this in the data sheet supplement for this month, and since it is similar in character to the information contained in this sheet, we reproduce Mr. Raeburn's contribution below. Subscribers will thus have it to compare with the proportions of flywheels given on the November data sheet. The following are directions for using the diagram here given:



Diagrams for Machine Flywheels.

Find diameter of flywheel on base line. Note the distance above this line to inclined line. Call this distance a. Find area of section of rim of flywheel on base line. Note the distance below this line to curved line. Call this distance b. $a + b = W$ = width of arm projected to center; $w = \frac{2W}{3}$; T = ½ width at any point.

* * *

Eye surgery in its simple forms must often perforce be practiced in the shop by the men, and many shopmen become very handy in removing foreign substances. Cinders and metallic particles, when superficially imbedded in the cornea of the eye, can usually be removed with little trouble by the skillful use of a toothpick or a match sharpened to a point which has afterward been slightly softened by chewing. But for particles more firmly imbedded so as to require more positive means of removal, a metallic instrument with an end shaped something like an oar and highly polished, may be found necessary. If strongly magnetized it will be of greater assistance in removing steel or iron pieces but will be no better for cinders, brass, or other non-magnetic substances. When metallic particles are of a ragged, irregular shape they may defy removal by ordinary means on account of clinging to the cornea with the barbs. In such cases the use of fine silk waste wound around the end of a toothpick is said to give very gratifying results. The silk threads catch upon the particle and tear it loose by simply moving the toothpick back and forth over the affected spot. Bandaging the eye and occasionally bathing it with a strong solution of salt and water is about the simplest and best after treatment to remove the inflammation.

* * *

A prime consideration in ocean telegraphy is to have a receiving and recording apparatus that works with the least possible resistance. The weak electric current that is necessarily used, is totally inadequate to work a Morse sounder or recorder, being the merest fraction of that required to work the most delicate relays used in land service. In Thompson's galvanometer a small mirror is delicately poised so as to be deflected by electro-magnets, and the deflection of the mirror is multiplied by a beam of light which is reflected on a scale. This delicate, but what is now considered to be a crude apparatus, is replaced by recording instruments of equal or greater sensitiveness which obviously have the great merit of producing a permanent record of all messages transmitted. To indicate what the extreme delicacy of this class of electric mechanism is, the improved Orling-Armstrong electro-capillary recorder may be mentioned. It is worked with a current of one-third volt through a resistance of a megohm or 1,000,000 ohms!

VARIABLE SPEED MOTORS.—7.

THE COMMERCIAL ELECTRIC COMPANY'S SYSTEM.

WILLIAM BAXTER, JR.

The variable speed motors manufactured by the Commercial Electric Company, of Indianapolis, are adapted to operate on any two-wire, or Edison three-wire power and lighting circuit. The variation in speed is obtained mainly by varying the number of wires upon the armature. The motor is provided with a double commutator armature, each commutator being connected with a separate set of armature coils. In this respect the system is somewhat similar to that of the C. & C. Company, but in its operation there is quite a difference; for while in the latter the two armature windings are connected in series to obtain a slow velocity, and in parallel for high speed, in the former the two windings are never connected in parallel. Owing to this fact, the two windings need not be made with the same number of turns; the actual proportion

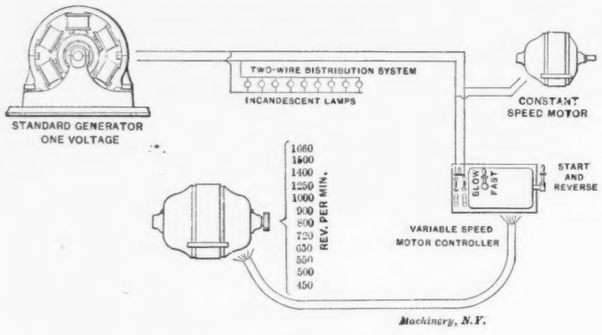


Fig. 1.

used is about two to three. To obtain the lowest speed both the armature windings are used, connected in series with each other. For an intermediate speed the winding having the smaller number of turns is cut out, while for the higher speed this winding is cut in and the one with the greater number of turns is cut out. The speeds obtained with these three connections of the armature circuits are about as follows: Slow speed, with both armature windings in series, 1; intermediate speed with long armature winding in service and short one cut-out, 1.7; high speed with short armature winding in service and long one cut-out, 2.5.

By means of field regulation several steps are obtained between the low and intermediate, the intermediate and high and above the latter speed. The low and the intermediate speeds are increased about 40 per cent, by means of field regulation, and the high speed is increased about 60 per cent., so that the total range of velocities is four to one, which is divided into twelve equidistant speeds.

The diagram, Fig. 1, illustrates the manner in which these motors are connected in an ordinary two-wire system in combination with incandescent lamps and other motors. The controller, which is of the reversible type, can be arranged so as to be actuated by means of a handle mounted directly upon it, or from any convenient point about the machine driven by the motor, through suitable connecting shafts and gears.

Description of the Controller.

The general arrangement of the controller, and the circuit connections between it, the motor and the supply mains, is clearly shown in the diagram, Fig. 2. The construction of the controller can be readily understood from Fig. 3, which shows the working parts, with the casing removed.

In Fig. 2, *A A'* represent the two armature windings, *A* being the long one, and *A'* the short one. As will be seen, these two windings are permanently connected in series with each other, and the operation of the controller is such that when the motor is started, *A* and *A'* are both in service. If the intermediate speed is desired, *A'* is cut out; and to obtain the high speed *A* is cut out, *A'* being left in service.

The parts marked from 1 to 21 are the stationary and movable contacts of the reversing switch shown as a rotating cylinder in Fig. 3. The parts marked from 22 to 34 are the contacts of the speed controlling switch shown at the top of Fig. 3. The controller is so arranged that by turning the shaft of the rotating reversing switch the speed controlling switch lever is also rotated; but the latter does not move until the reversing switch has turned far enough to cut out the starting resistance and the series field coils of the motor, so as to leave only the shunt field coils in service, and thus enable the motor to run at a constant velocity for any speed at which

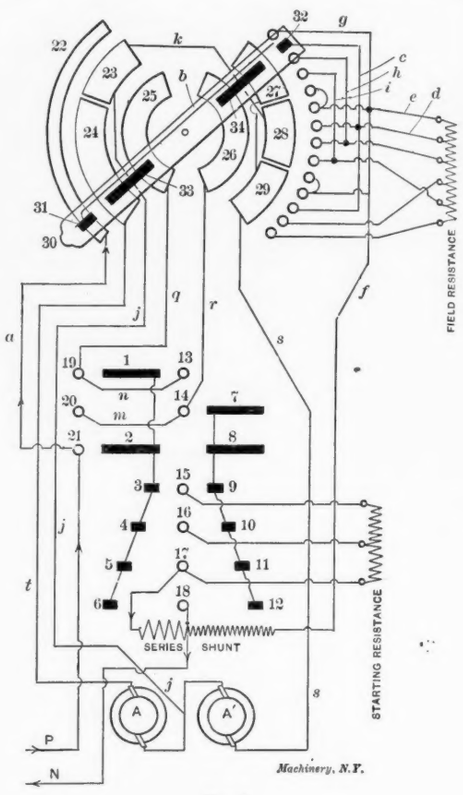


Fig. 2.

the speed controlling switch may be set, regardless of changes in the load. The reversing switch cuts out the starting resistance and the series field coils in four steps.

Circuit Connections and Operation of the Controller.

The circuit connections in Fig. 2 are as follows: The lines *P N* connect with the source of current supply. If the switch lever 30 is in the position shown, and *P N* are connected with the mains by closing the main switch, the current from *P* will flow to 21, thence through *a* to contact arc 22, and through

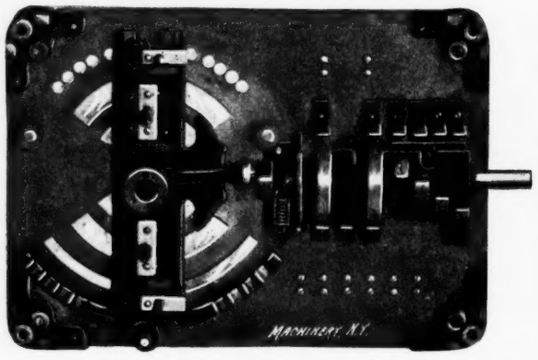


Fig. 3.

contact 31 on lever 30 and wire *b* to contact 32, and thence through wire *c* to wire *d*, and through upper section of the field resistance to wire *e*, and thus to wire *f*, which connects with one end of the shunt field coil of the motor. The other end of the shunt field coil is connected with line wire *N*, thus completing the circuit through the shunt field. If lever 30 were drawn so that contact 32 rested upon the top circular contact, the current would pass directly to wire *f*, through wire *g*, and thus avoid passing through the upper section of the

field resistance. This latter is the position of 30 when starting.

If now the reversing switch is turned to the left so as to set the motor in motion, stationary contact 21 will be covered by cylinder contact 2, and 19 by 1. Contacts 7 and 9 will ride over 14 and 15 respectively, and the circuit through the armature will be, from 21 to 2 and 1, thence to 19, to q, to 25 and through connecting contact 33, to 24. From here, through wire t, to armature winding A, through the latter to winding A' and thence to wire s and contact 29. As 29 and 27 are connected by wire, the current will pass to the latter and thence through 34 to 26 and to wire r, which connects with

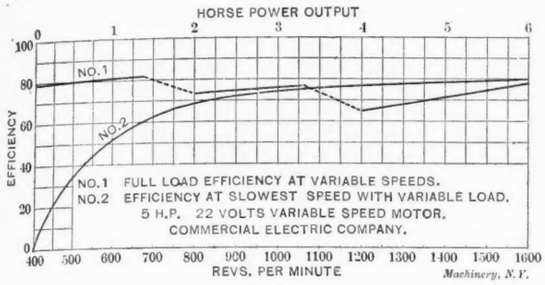


Fig. 4.

14. From 14 through cylinder contacts 7 and 9 the current reaches 15, and then passes through the starting resistance to contact 17, thence through the series field coil to line N.

When the reversing switch is moved to the second step, cylinder contact 10 rides over 16 and cuts out one section of the starting resistance. When the third step is reached contact 11 rides over 17 and cuts out the remaining section of the starting resistance, and on the fourth step contact 12 rides over 18 and cuts out the series field coil.

During all this time the switch lever 30 does not move from its initial position, but, upon the further advance of the controller, 30 rotates clockwise so as to carry contact 32 over the row of circular contacts and thereby cut in sections of the field resistance. While 34 remains in contact with 27 there is no change on the armature winding connections, but the speed of the motor is increased from step to step through the cut-

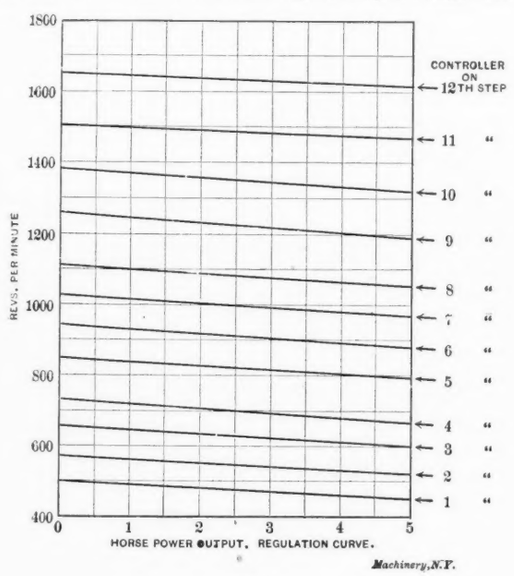


Fig. 5.

ting of resistance into the shunt field circuit. On the first step the current passes through wire g; on the second step it passes through wire c, and cuts in the upper section of the resistance. On the third step it passes through wire h and cuts in the two upper sections of the resistance. On the fourth step it passes through wire i and cuts in the four upper sections of the resistance. In passing to the next step, lever 30 carries 34 over onto contact 28 and at the same time connects with wire e and cuts out all the field resistance. As soon as 34 passes onto 28 the armature winding A' is cut out, because then the current from the junction of the two windings, A and A', can pass through j to 23 and thence, through k, to 28. While 30 is advancing and carrying 34 over 28 the sections of the field resistance are again cut into the field circuit, one at a time, thus increasing the motor speed step by step. When 30 advances far enough to carry 34 over 29, A will be cut back into circuit, and A' will be cut out. As will be seen when this position is reached, 33 will be in contact with 23 instead of 24, so that the current from line wire P instead of

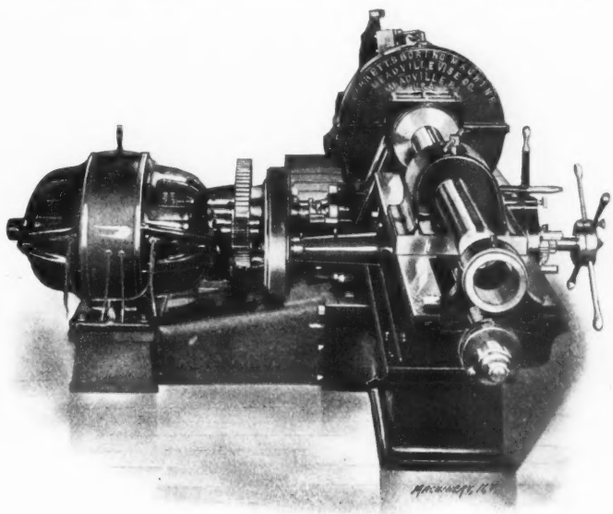


Fig. 6.

passing to 24, and thence to t and to A, will pass to 23 and through j to A'; and from the end of A' it will pass to 29 and thence to 26 and out to wire N in the manner already explained.

While 34 is being advanced over 29 the sections of the field resistance will be again cut in, one at a time, and when the final step is reached all the sections will be in service.

In the first two connections of the armature coils only four of the field resistance sections are cut into the field circuit; but in the last connection all the sections are brought into service. In this way the increase in speed obtained by the use of field resistance, for the first two connections is made about 40 per cent. while for the last one it is about 60 per cent.

To run the motor in the opposite direction the reversing switch cylinder is rotated to the right, and then contact 8 rides over 21, contact 7 over 20, contact 1 over 13, and contact 3 over 15. With these changes in the reversing controller connections the path of the current will be as follows: From 21 to 8 to 7 to 20, through m to 14, through r to 26 to 34 to 27 to 29 and through s to and through the armature windings A' A to wire t and to 24. From 24 through 33 to 25, and through q to 19, through n to 13, thence to 1 to 3 to 15 to 17, and through the series field coil of the motor to line N. As the controller is advanced the contacts 4, 5, 6 slide over 16, 17 and 18, one after the other, and cut out the starting resistance and series field coils as previously explained. The further advance of the controller actuates the speed controlling switch 30 in the manner already described.

Torque, Power and Efficiency of "Commercial" Motors.

When the two armature windings are in service the current traverses about two-and-a-half times as many turns of wire as when the short winding is used alone; hence, with the same strength of current, the torque in the two cases will be about in the ratio of two and a half to one. For any portion, or the whole of the armature wire in service, the torque with a given current through the armature will decrease as the field is weakened, or, in other words, as the speed increases. The reduction in torque will be directly proportional to the increase in armature speed. From this it will be seen that the power developed by the motor will be practically the same at all velocities.

When all the armature wire is in service, the loss of energy

in the armature will be greater than when either of the windings is used alone, for the same current strength, but if the armature resistance is small, this difference will have only a slight effect on the motor efficiency. The diagram, Fig. 4, furnished by the Commercial Company, shows that at full load

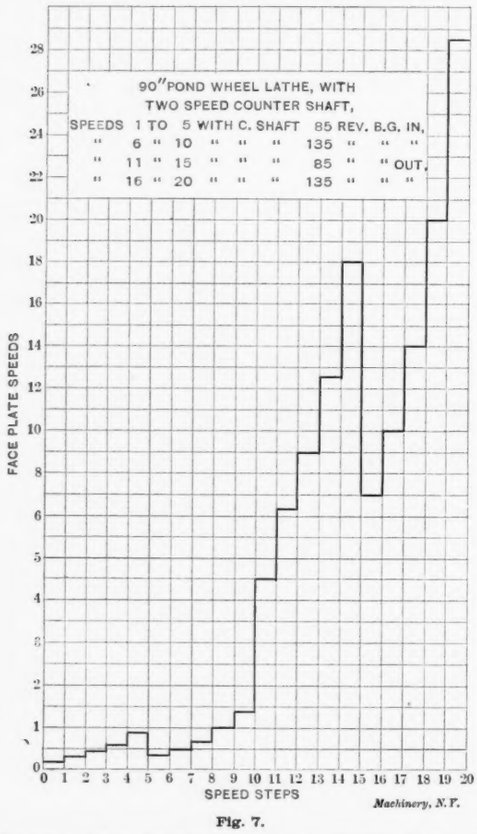

90" POND WHEEL LATHE, WITH
TWO SPEED COUNTER SHAFT,
SPEEDS 1 TO 5 WITH C. SHAFT 85 REV. B.G. IN,
" 6 " 10 " " " 135 " " "
" 11 " 15 " " " 85 " " OUT,
" 16 " 20 " " " 135 " " "
FACE PLATE SPEEDS
SPEED STEPS
Machinery, N.Y.

Fig. 7.

the efficiency of the motor changes but slightly for any speed from the lowest to the highest. This diagram also shows, in curve 2, that at the lowest speed the efficiency remains high as the load is reduced to about 25 per cent. of the maximum; below this point the efficiency naturally drops rapidly.

Variation in Speed Due to Changes in Load.

As already explained the motor when running has all the resistance cut out of the armature circuit, and also the series

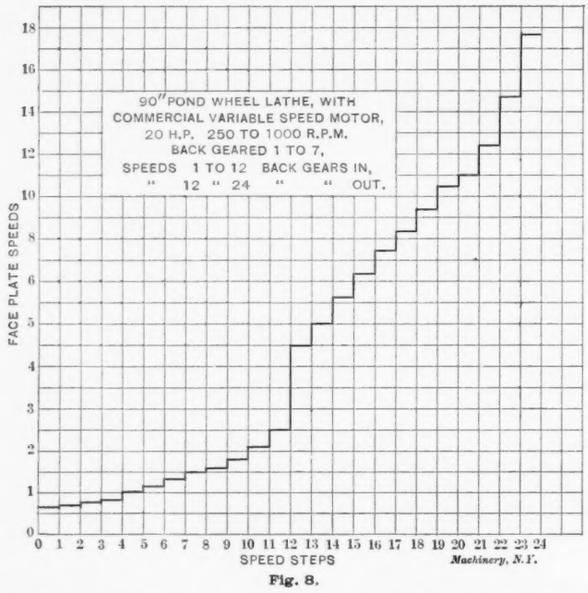

90" POND WHEEL LATHE, WITH
COMMERCIAL VARIABLE SPEED MOTOR,
20 H.P. 250 TO 1000 R.P.M.
BACK GEARED 1 TO 7,
SPEEDS 1 TO 12 BACK GEARS IN,
" 12 " 24 " " OUT.
FACE PLATE SPEEDS
SPEED STEPS
Machinery, N.Y.

Fig. 8.

field coils; therefore, when the speed controller is set for any given velocity the change in speed effected by varying the load cannot be very great. What this change actually amounts to is shown in Fig. 5. At the bottom of the diagram the power output is marked, and on the left side the revolutions per minute. On the right side the several steps of the speed controller are marked. The speed lines across the face of the diagram show that between full load and no load the change in velocity is about fifty revolutions per minute. Thus on the 10th step the velocity with full load is about 1325, and with no load about 1375.

The way in which Commercial motors are mounted upon machine tools is well shown in Fig. 6.

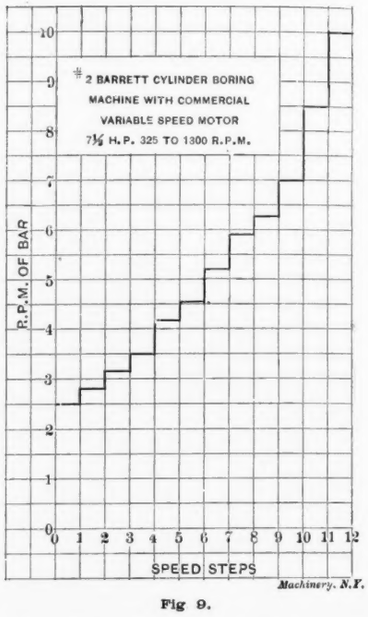


Fig. 9.

Some Points on Speed Variation.

Diagrams 7, 8 and 9 show that in some cases the speed variations effected by the mechanical speed-changing devices furnished with machine tools are not as uniformly progressive as they should be, and that in such cases an improvement can be made by using a variable speed motor to produce a part of the speed variation. A perfect speed-changing device would be one in which each step produces a proportionate increase in velocity. In many machine tools, however, the relation of the gearing is such that when the back gear is thrown out and the belt is placed on the slowest cone step, the velocity is materially reduced. This fact is clearly brought out in Fig. 7. In this diagram the speed advances during the first five steps, but here the countershaft speed is increased and the speed of faceplate drops on the 6th step to slightly more than it is on the 2d. The speed again advances uniformly up to the 10th step, when it takes a decided jump in consequence of the change in countershaft speed and the throwing out of the back gear. At the 16th step there is another decided drop in faceplate speed due to changing the countershaft speed.

Fig. 8 shows the same tool driven by a variable-speed motor instead of a two-speed countershaft, and, as will be noticed, the faceplate speed variation is far more uniform; in fact the only break, occurring on the 12th step, is due to throwing the back gear out. If the back gearing were properly proportioned to the range of motor velocities, this sudden rise in velocity when the back gear is thrown out could be prevented. The same result could be obtained by providing a motor with a somewhat greater range of speeds.

Fig. 9 shows the speed variations obtained on the tool of a boring mill by the use of a variable-speed motor alone.

* * *

The artificial corundum, called "corubin," that is obtained from the slag produced by the Goldschmidt thermit welding process, is much purer than the natural corundum. For this reason it is possessed of a very valuable property to the chemist, and that is the ability to resist sudden great changes of temperature without breaking. Chemical vessels made of fireclay and corubin may be heated redhot and plunged into cold water without breaking or even showing any tendency to crack.

THE DE LAVAL STEAM TURBINE AND ITS MANUFACTURE.

In the Engineering Edition for October was published a general account of the inventions of the noted Swedish engineer, Gustaf De Laval, together with a description of the steam turbine machinery manufactured in this country under his patents, and a description of the De Laval Steam Turbine Works at Trenton, N. J., where the machinery is produced. In this article it is intended to enter more into detail upon the construction of the De Laval steam turbine and the interesting methods of manufacture that have been developed at the American works.

The plant is unusually well equipped with jigs, fixtures and special tools. Micrometers and gages are in evidence, not only for tool room use but for the employes in the shop as well. There is a large tool-making department, which apparently is kept busy, in addition to the tool room where the tools are stored, to be checked out in the usual manner. The drawings are kept in the tool room and an ingenious system is used in giving them out to the workmen. The turbine parts are marked with a number designating the particular part, prefixed by a letter for the size of the machine. Each drawing is devoted to a single part and bears the same character as that part. A board hung in the tool room contains a large number of pins having numbers corresponding to those of the turbine parts. When a workman hands in his check for drawing R-126, for example, it is hung on pin 126 and a small metal clip, lettered R, is slipped over the edge of the check. The number on the check shows who the workman is; and the clip, together with the number of the peg on which the check hangs, shows what drawing has been given out.

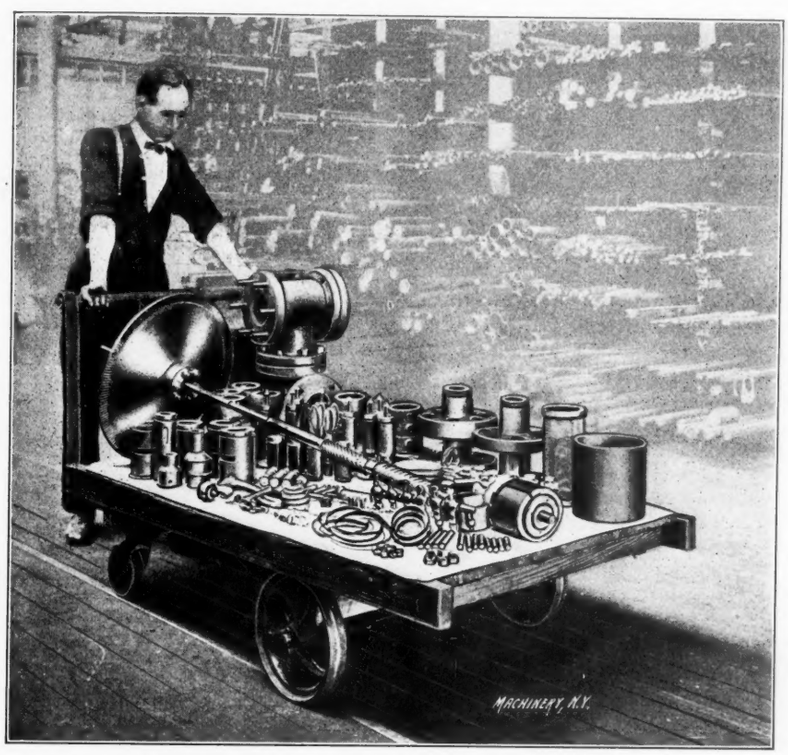


Fig. 1. The Small Parts of a 300 H. P. De Laval Turbine as taken from the Stock Room, ready for Assembling.

Another feature of the De Laval works is the stock room for finished parts. All the small pieces are made up in large numbers, carefully inspected and placed in stock. The larger parts consisting of the frames, bedplates, etc., are also made up in lots, though of smaller numbers, and when one or a series of turbines is to be erected, the parts are taken from the stock room, complete, and ready to put together, with the exception of such slight fitting as may be required during the assembling.

In Fig. 1 is shown a truck, loaded with the small parts of one complete turbine, as it is brought from the stock room to be carried to the erecting shop. Here are the wheel and shaft, the gearing, bearings for the several shafts, flexible couplings for connecting the gear shafts with the generator or other machine to be driven by it, the steam nozzles, valves, governor, regulating valve, lubricator, etc.

The line drawing, Fig. 2, is a horizontal sectional view of a turbine, taken through the turbine and gear shafts. Starting at the right, *W* is the turbine wheel, attached to the flexible shaft which is supported on each side of the wheel by bearings held in the casing by ball and socket joints. The pressure within the turbine casing is practically atmospheric pressure when running non-condensing, and is equal to the pressure of the condenser when running condensing. Under the latter conditions, these bearings should be tight to prevent leakage of air into the casing, and they must at the same time be able to move slightly, in case of flexure of the shaft. They are, therefore, held to their seats by spiral springs *N* bearing against a collar *O* made in the form of a socket. At the other end of the flexible shaft are the spiral pinions *K*, supported on each side by bearings *C* in the wheel casing. These pinions mesh with the gears *I I*, as indicated.

The speed reduction between the pinion and gears for all sizes of turbines is about in the ratio of 10 to 1. The speeds of the turbine wheels range from about 30,000 revolutions per minute for a 7-horse power to 10,600 for a 300-horse power turbine; and the speeds of the large gears range from about 900 to 3,000 revolutions per minute. The peripheral speed of the turbine wheels ranges from about 515 to 1,380 feet per second, while the peripheral speed of the gears is 100 feet per second or slightly more, for all sizes. These speeds of the gear shaft are found to be well adapted to driving generators and other apparatus, such as centrifugal pumps, blowers, etc. Such apparatus is driven through flexible couplings taking power from the outer ends of the gear shafts. The couplings have a series of pins *F*, Fig. 2, securely driven into holes in the circumference of the driving disks, and on their outer ends have rubber bushings *E*, which fit in corresponding holes in the disk attached to the shaft belonging to the generator or other apparatus. These bushings are fitted with an internal steel bushing *D*, which slips over the end of pin *F*, to protect the rubber. This brings the wear on the outside of the rubber bushing, which presents a greater area than the inside.

The governor, shown at *M*, is of compact design and is carried by a short shaft made a taper fit in the end of one of the gear shafts. The governor controls a throttle valve and also, in case of extreme increase in speed, opens a valve admitting air to the wheel casing by means of the lever *V*.

Nozzles and Steam Chest.

In considering the individual parts of the De Laval turbine more in detail the first to be noted are the nozzles which direct the steam against the wheel buckets and which have been one of the characteristic features of the De Laval system. These nozzles are arranged about the circumference of the steel casting which serves as the casing for the turbine wheel. The inner end of this casting has an annular closed space, separate from the wheel chamber, which serves as a steam chest for the turbine, as indicated in Fig. 2. The inner ends of the nozzles open into this steam chest, as shown in the sectional view, Fig. 3. Here *A* is the steam chest; *B*, the nozzle; *D*, the turbine wheel, and *C*, the valve for admitting steam to the nozzle. The divergence of the nozzles depends upon the steam pressure to be used and also upon whether the turbine

is to run condensing or non-condensing. If the latter, the turbine is generally fitted with both condensing and non-condensing nozzles, so that in the event of difficulty with the vacuum the machine can be operated non-condensing with a greater degree of economy. These nozzles are turned to gage on their outside and reamed to the required taper on the inside. Over 600 reamers of different tapers are kept in the tool room for this purpose. The nozzles are simply driven into place in the casing, but are threaded at their inner ends to facilitate removal by means of a jam nut. The taper of the nozzles ranges from about 6 to 12 degrees total taper, and they are located with their outlet about ⅛ inch from the wheel blades.

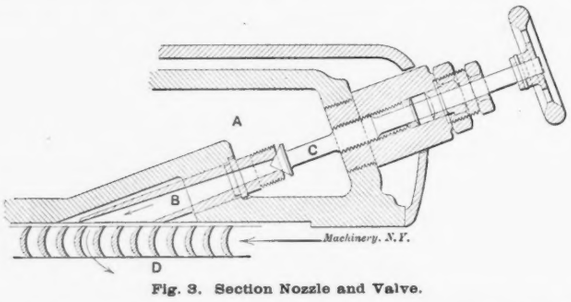


Fig. 3. Section Nozzle and Valve.

Turbine Wheel and Shaft.

The turbine wheels are all made in Sweden, of a special grade of high-carbon steel. They are shaped according to theoretical calculations, so as to offer nearly a uniform resistance throughout to the forces acting; but they are made slightly stronger near the center. A short distance from the periphery annular grooves are turned on each side of the wheel, making this the weak section which would be ruptured first in case of excessive rotative speed. To further guard against danger in the case of a wheel bursting the casing is a steel casting strong enough to sustain the shock due to flying segments of the wheel; and still further, the hubs of the wheel extend into circular openings in the casing, as shown in Fig. 2, in which the hub ordinarily runs without touching. But if the wheel rim should burst, what would be left of the wheel would be out of balance and would cause the hubs to bear against the casing with great force and thus slow down, and perhaps stop the turbine before further damage could be done.

Grooves of the shape shown in Fig. 5 are drilled and milled through the turbine rim in a crosswise direction, and in these drop-forged steel buckets are fitted. This construction enables buckets to be easily renewed, as is sometimes necessary either because of wear or accident.

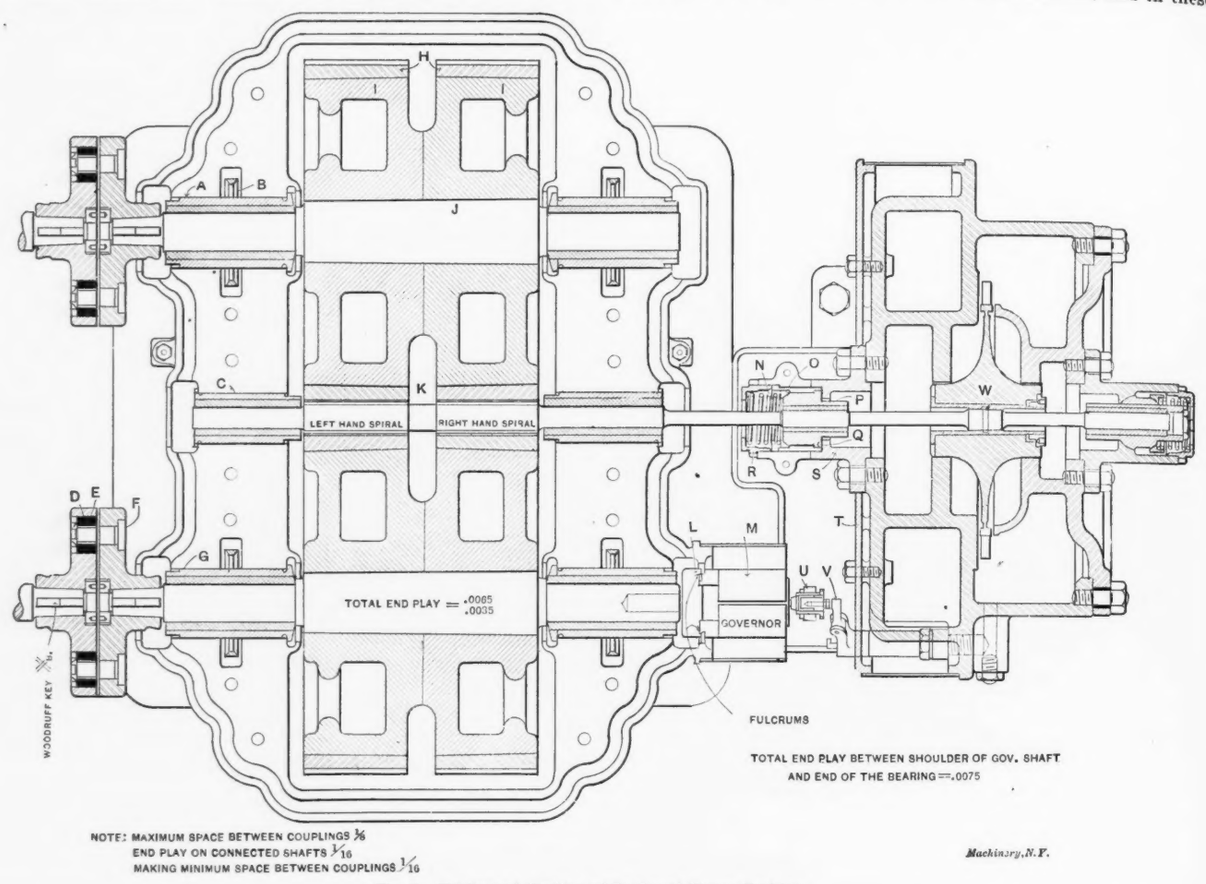


Fig. 2. Horizontal Section of De Laval Steam Turbine.

In the smaller size turbines the wheels are attached to the flexible shafts by the method indicated in Fig. 2. The hubs of the wheels are bored out and a thin steel bushing is drawn into the hub by a nut at one end. The middle portion of the bushing is bored tapering and fits on a taper portion of the shaft, as indicated. This taper is the standard ½-inch per foot used by the De Laval Company. After forcing the bushing on the shaft, it is pinned into place; but the wheel can easily be removed by loosening the nut and sliding it off the steel bushing. The wheels for the larger turbines are made as in Fig. 4. Here the hub is solid at the center, but each end of the hub is recessed and the flexible shaft is made with enlarged flanged ends which fit into the recesses and are bolted solidly in place. The recesses and shaft ends are machined on a taper of ½ inch per foot, which enables the parts to be accurately centered and fitted solidly together.

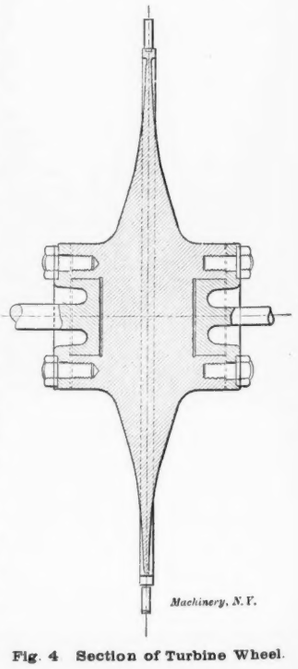


Fig. 4 Section of Turbine Wheel.

The pinions are cut directly on an enlarged portion of the shaft. The steps of manufacture are: First, to straighten, turn and square up the various shoulders on the shaft; second, to rough-cut the pinions; third, to finish by grinding, and fourth, to take the finishing cut on the teeth of the pinions. The shaft and wheel are then assembled and tested on centers, where they are run at high speed to determine the accuracy of balance. The flexibility of the shaft, which is an

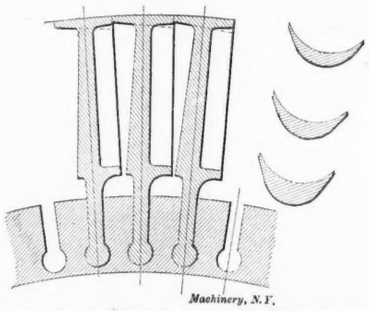


Fig. 5. Showing Construction of Turbine Buckets.

important feature of the De Laval turbine, makes an extremely accurate balance unnecessary since the wheel and shaft reach the critical speed, so-called, at about 1-5 to ⅛ of the normal number of revolutions of the wheel, at which point "settling" takes place and the parts proceed to rotate about their center of gravity instead of about their geometrical center.

Gears.

Next in importance to the turbine wheel, and probably first in importance in so far as the successful operation of the turbine is concerned, are the gears used to reduce the speed of the turbine shaft to a point where it is practicable to utilize the power. It was a radical step on the part of De Laval when he first attempted to run gearing at so high a speed as these gears operate, and it is safe to say that previous to the time when De Laval demonstrated that gears would run at a linear velocity of upward of 100 feet per second, it would not have been supposed possible.

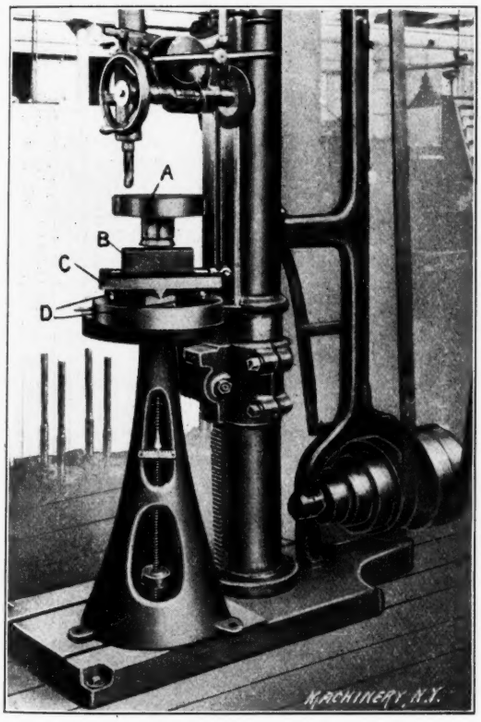


Fig 7. Machine for Balancing the Rotative Parts of the Turbine.

The pinions are made of 60- or 70-point carbon steel and are a part of the flexible shaft. The gears are of mild 20-point carbon steel of a grade similar to that used for car wheel tires. For turbines up to 30 horse power the gears are of solid steel; but for sizes above that they are made with cast-iron centers with rims of mild steel. The teeth are of fine pitch, ranging from about .15 inch in the smallest to .26 inch in the largest sizes. The success at running these gears at high speed is due, in part, to the fine pitch and the spiral angle of the teeth, which thus brings a large number of teeth in mesh at one time, making the working pressure at each tooth very light, and reducing the likelihood of abrasion. The dimensions of gears and pinions for four sizes of turbines are shown in the accompanying table:

H. P.	Outside Diameter.	Number of Teeth.	Depth of Teeth.
	PINIONS.		
10	1.077	21	.075
75	1.53	19	.1169
110	1.82	23	.1169
300	2.65	31	.1275
	GEARS.		
10	10.1	208	.075
75	15.7	208	.1169
110	18.89	250	.1169
300	29.29	362	.12750

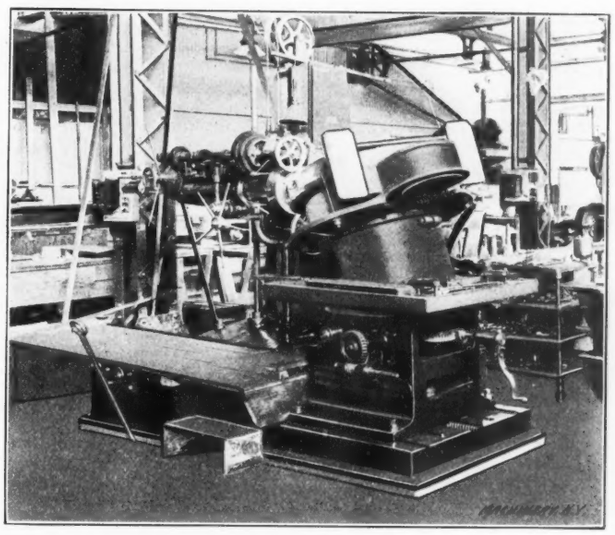


Fig. 6. Boring the Holes in Wheel Casing for the Nozzles, by means of a Special Fixture on the Boring Machine.

A practice somewhat out of the ordinary is employed by the De Laval company in putting together the shafts, gear centers and rims that make up the large gears, as well as in other parts of the turbine, where applicable. This is the use of the ½-inch per foot taper already referred to. The angle of this taper is so far below the so-called friction angle, or angle of repose, that pieces turned to this taper and fitted together hold with practically as great rigidity as straight, parallel surfaces would hold and at the same time can be pressed together much easier and without abrading the surfaces. The taper accomplishes the same object as where the surfaces to be pressed together are turned in steps, and on the whole this is a more easily applied system when fitted up for it.

Balancing

Inasmuch as the disks are quite accurately balanced when they reach the factory, and moreover are mounted on a flexible shaft, it answers every requirement to run them on centers in the usual manner, in order to test their balance. The parts of the turbine attached to the gear shafts, however, are not flexibly supported and are better balanced by a more accurate means. The machine shown in Fig. 7 was devised for this purpose, and is shown with one of the flanges for a flexible coupling mounted on an arbor at *A*, ready for balancing. The machine is placed under a drill press and by its aid the heavy side of the casting is located and enough metal drilled out to bring the flange into balance. On top of the stand are located knife edges which carry a table *C* with a movable cross-slide *B*. This cross-slide is fitted with a pendulum in the form of a screw which runs down into the base and has a weight at its lower end. Half way up there is a pointer and a graduated scale for indicating the position of the pendulum. The arbor for supporting the piece to be balanced is at the top of the slide *B*. By adjusting the slide one way or the

other the indicator is brought exactly at the center of the scale and then the coupling is turned around half-way by hand without moving the slide. If the indicator does not move, it shows that the coupling is in balance at this point; if it does move, the coupling must be out of balance and the necessary drilling is done. From eight to a dozen points around

There are two vertical machines and two horizontal machines in the gear-cutting department working on this plan. In order to secure great accuracy in the angle of the teeth, the machines are all provided with an attachment shown in principle, though not in actual detail of construction, in Fig. 10. *C* is the cutter head, which travels downward with the

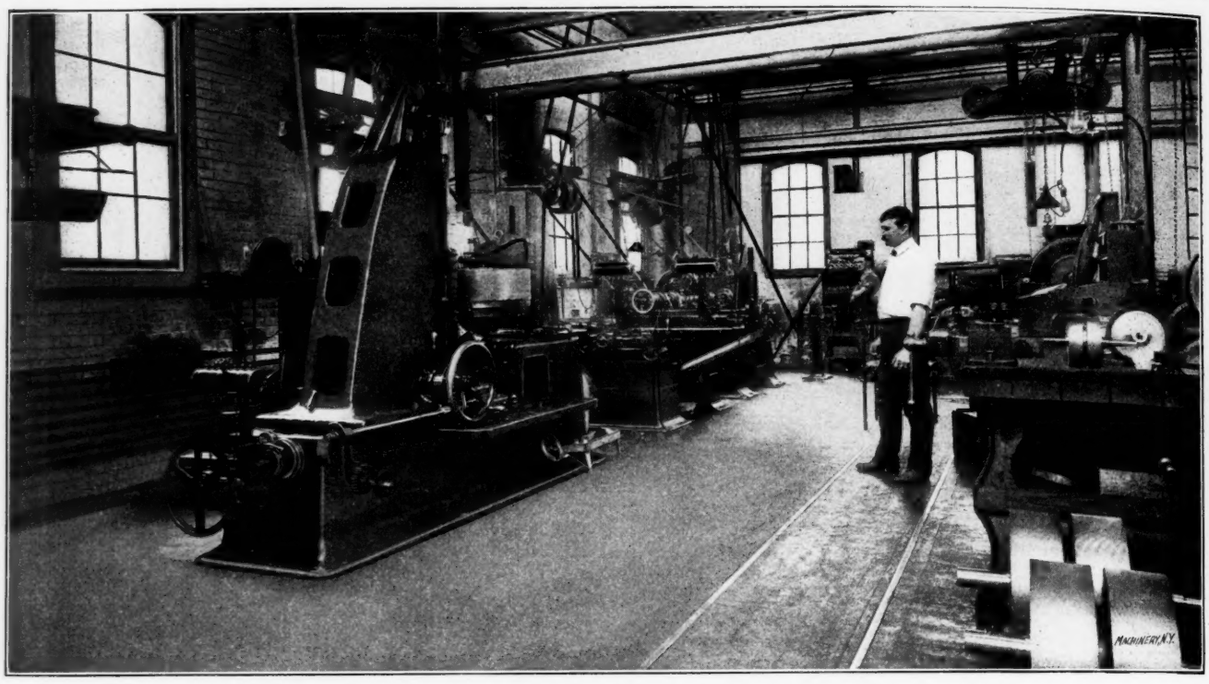


Fig. 8. Gear-cutting Department equipped with Special Machines for Hobbing the Teeth of Spiral Gears.

the circumference of the coupling are tested in this manner. In order to steady the table and avoid wear of the knife edges when drilling, there are pins *D D* which are raised against the bottom of the table by a cam and which take the strain.

Gear Cutting.

As a matter of course high-speed gears must be accurately cut and their shafts mounted in their bearings so as to be exactly parallel, if smooth running is to result; and unusual precautions are taken to secure a high degree of accuracy in

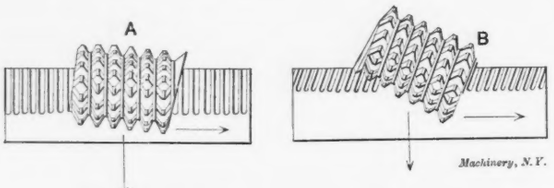


Fig. 9. Illustrating the Principle of the Cutters.

cutting and mounting the gears of the De Laval turbine. Fig. 8 shows the gear-cutting department with its complement of machines built expressly for this work by the Pratt & Whitney Co., Hartford, Conn., in accordance with designs furnished by the De Laval Steam Turbine Co. In these machines the gears are cut by a hobbing process, a spiral cutter being used for a hob. The principle of operation is shown in Fig. 9. At *A* the spiral hob is set so as to cut the teeth of a spur gear. The hob feeds downward across the face of the gear and at the same time the gear rotates as fast as it would be turned around if the hob were a worm meshing in the teeth of the gear. If the hob has a single thread it would have to make as many turns as there are teeth in the gear for each rotation of the gear. At *B*, Fig. 9, the hob is shown inclined still more so as to cut spiral teeth on the wheel. This can be accomplished by giving the cutter either a greater or lesser number of revolutions for each rotation of the gear, according to whether a right-hand or a left-hand spiral is to be cut. In producing a gear the cutting action is continuous from start to finish, so that if the machine is rigid, the best possible results are attained.

cutter in a vertical direction. *G* is the gear to be cut, mounted on the work spindle which is revolved by a wormwheel. The wormwheel and gear blank are driven by a worm which is given the desired rate of rotation by a system of change gears. Now it is evident that if the change gears used do not produce exactly the right result the correction could easily be made if some means were provided for moving the worm bodily in a longitudinal direction, so that in addition to its driving the wormwheel through its rotation, it also either pushed it ahead or pulled it backward, so to speak. This is what is done by means of a slide shown at *D*, arranged to swivel on a graduated dial which moves up and down with the cutter head. The worm is carried by a sliding frame having a block *R* traveling in the slide *D* so that, when the slide is placed at an angle, any movement of it up or down will give the worm its longitudinal movement. As the slide can be set very accurately by vernier readings, exactly the correct spiral angle can be obtained, independent of the change gears.

Testing the Gearing.

The need for securing so great accuracy of angle will be evident when it is remembered that not only are double spiral

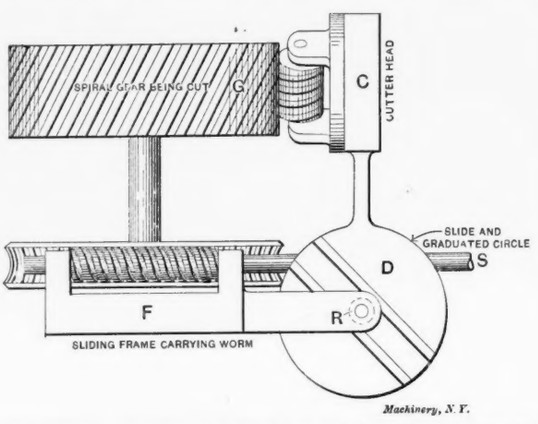


Fig. 10. Diagram showing Method of Securing Accuracy of Spiral Angle of Gear Teeth.

gears used in each turbine, cut right and left, but also that the two right- and left-hand pinions on the turbine shaft lie between two pairs of gears, making what are really two spiral pinions, each of which must mesh with two opposite spiral gears. This will be clear from reference to Fig. 2, which shows the positions of the gears. It goes without saying that

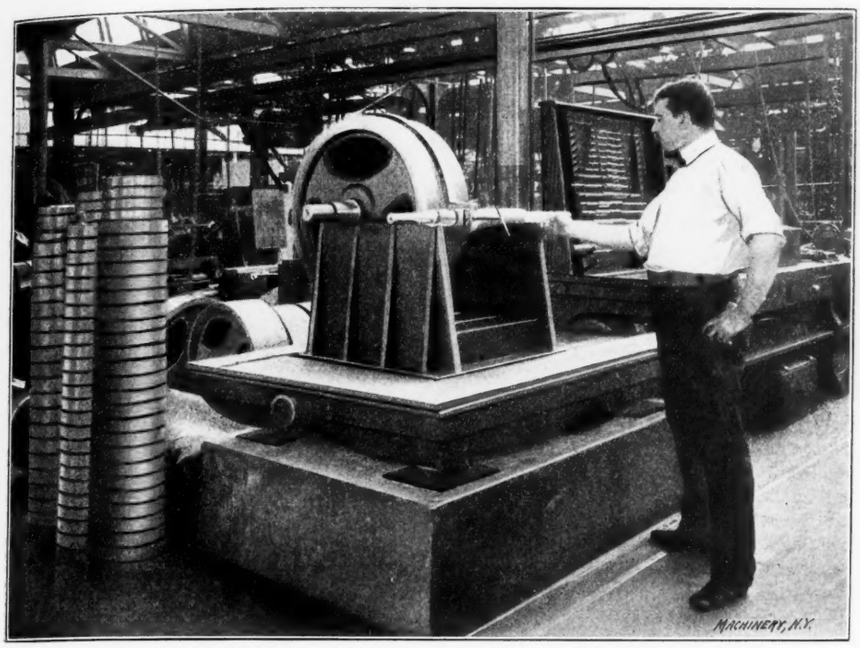


Fig. 11. Testing the Spiral Gears and Pinions to see that Shafts are parallel and in same Plane.

it requires rather unusually fine workmanship and painstaking care to have these teeth so correctly cut that they will all mesh in perfect alignment. The method of testing for the angle of the teeth is shown in Fig. 11. There are two parallel straight edges with their top surfaces lying exactly in the same plane upon which the gears are mounted. The gear shafts rest on the top edges of these parallels, and a pair of large gears and a pair of pinions are clamped together, with their teeth in mesh, by an iron band passing around the large gears and arranged with a screw which draws the pinions into contact with the gears. If the two shafts lie in the same plane it is evident that a piece of tissue paper under each end of the pinion shaft would just "draw," and this is the test applied and actually required before the gears are considered to be aligned correctly. A little consideration will show the extreme accuracy of this test, and will indicate how much attention is given to securing the correct spiral angle of the teeth.

The Wheel Casing.

Without correctly aligned bearings the most accurate gear would run noisily, and Fig. 12 illustrates the simple yet effective method used to secure parallelism of the three gear shafts and also to make sure that they are in the same plane. The gear case is first bored out on the horizontal boring machine, being held in a special jig. The bearing pockets are afterward carefully scraped to standard test bars which are brought to their proper center distance by the use of a caliper gage, as shown in the illustration. The gear case rests on a large surface plate and a Brown & Sharpe test indicator, also shown, is employed to bring the test bars into exactly the same plane. This is done by placing the indicator on the surface plate under the shafts at the various points where they protrude past the case. The surface plate is mounted on a heavy foundation and has adjustable legs, so that it can be readily leveled.

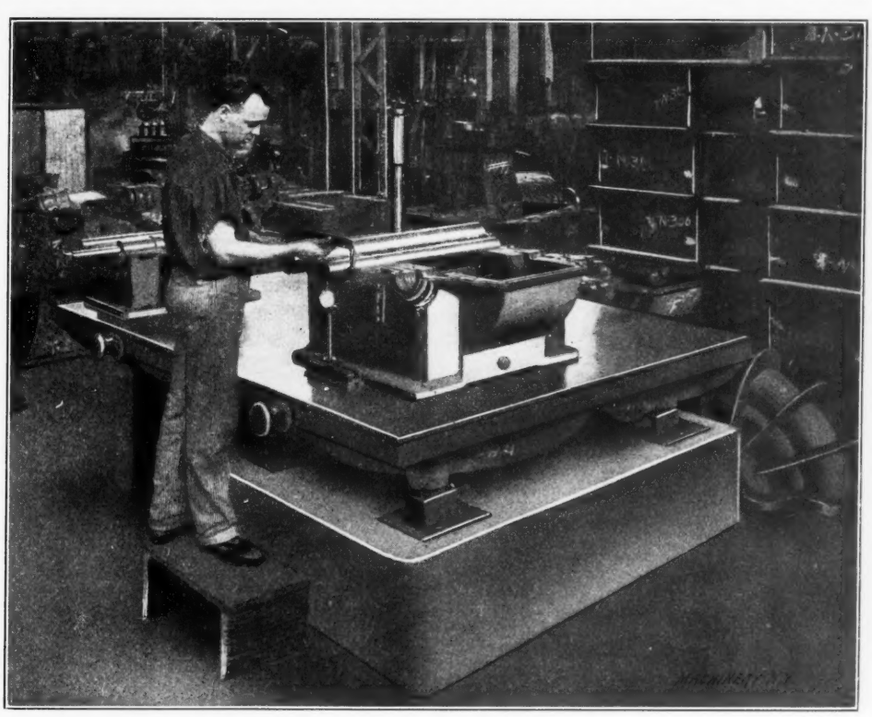


Fig. 12. Testing Pockets for Bearings in Wheel Casing to insure that Gear Shafts will be Parallel and in the same Plane.

Bearings.

All bearings are lined with babbitt and special attention must necessarily be given to their construction to have them adapted to the high speeds of the parts that run in them. The bearings are all in the form of cylindrical shells, either split or solid, excepting those which act as glands in the turbine casing which are turned in the form of a ball at the center and are held in position by sockets. The low-speed bearings are made with cylindrical shells of special composition, lined with babbitt and ring-oiled. Before babbitting, the shells are cleaned in nitric acid. The babbitting is done by first heating the shells and then bedding them in molding sand and pouring in enough babbitt to fill the shell flush with the top. The molten metal is then agitated by means of a stick, which causes the impurities to rise. By this process such impurities reach the center of the bearing, where they are bored out, leaving a solid lining of pure metal.

In the high-speed bearings oiling is accomplished by having a shallow spiral groove turned in the shell, which allows the oil to reach every part of the bearing. In a 100 horse power machine this groove is about 1-64 inch deep of ½-inch pitch. The bearings are first milled and scraped together and then bored and reamed under the drill press in a special jig shown in Figs. 15, 16 and 17, before they are turned. Figs. 15 and 16 illustrate the drilling of a split bearing, and Fig. 17 the drilling of a solid bearing. The jig is

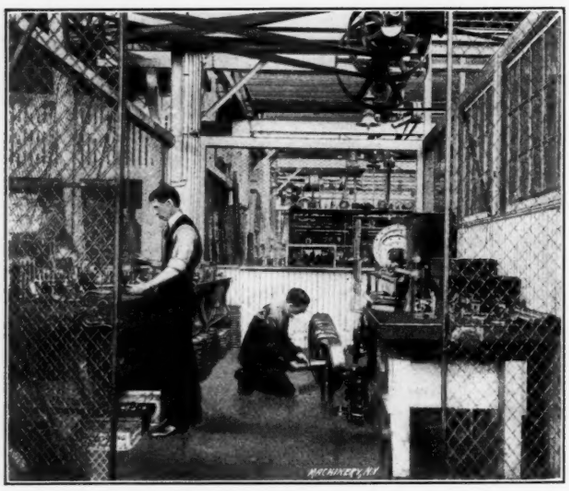


Fig. 13. Inspecting Department. This Room is enclosed to Guard against Interruptions that might lead to Errors or Oversight on the part of the Inspectors.

box-shaped with a swinging holder at the top in which the drill bushings are located. Fig. 16 illustrates the method of locating split bearings in the jig so as to insure drilling and reaming of the hole in the exact center of the bearing. The center plate which the man has in his left hand, and which is shown standing beside the drill press in the other views, is inserted in grooves milled in the jig so that one face of the plate is exactly in line with the axis of the bushing through which the hole is to be drilled. The split bearing is then placed with its milled edges against the face of the plate, Fig. 16, and two sliding V-clamps are brought up so as to hold it against the plate, and at the same time align the bearing in a vertical direction. The plate is then removed and the other half of the bearing is placed against the first half, and two more sliding vees are brought up against this second half, on the opposite side of the jig. After this the bushing is brought into position, if it is to be used.

a gage glass, to indicate the quantity of oil in them. The oiling of the various bearings is effected by means of a single sight-feed lubricator having tubes leading to them.

Other Departments.

Fig. 14 shows the machine recently constructed for cutting out asbestos gaskets, which are used chiefly in the pipe joints. They vary from 4 and 5 inches in diameter up to as high as 38 inches in diameter. They were formerly cut out by knives, with the result that considerable material was wasted. The gaskets are now cut out on the top of a table on which is fastened a sheet of zinc and at the center of which is located a center pin on which swings an adjustable cutting rod, which the man in the illustration has in his hand. This

Fig. 14. Device for Cutting out Asbestos Gaskets

rod carries from 1 to 6 adjustable knife rollers. These rollers can be clamped to any point on the rod and fastened by thumb screws. By swinging the rod around very smooth gaskets are cut with one or two turns. Lying on the floor are a number

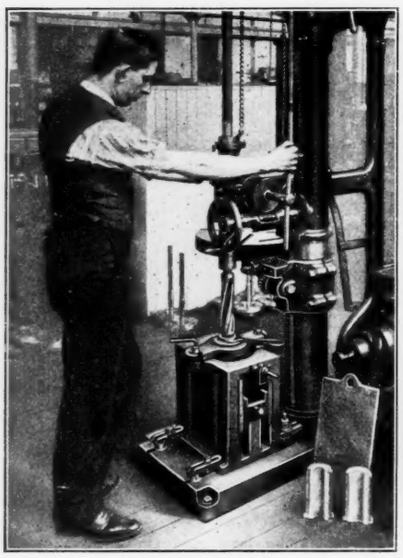


Fig 15.

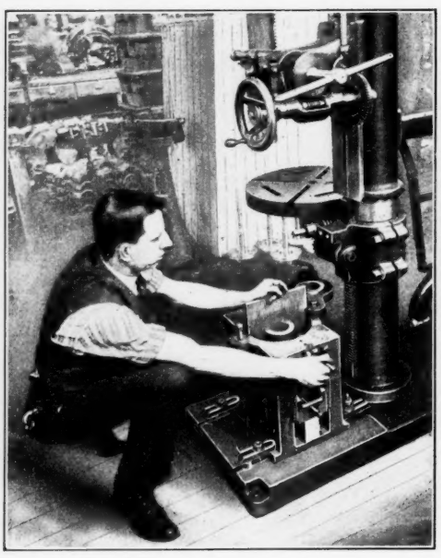


Fig. 16.

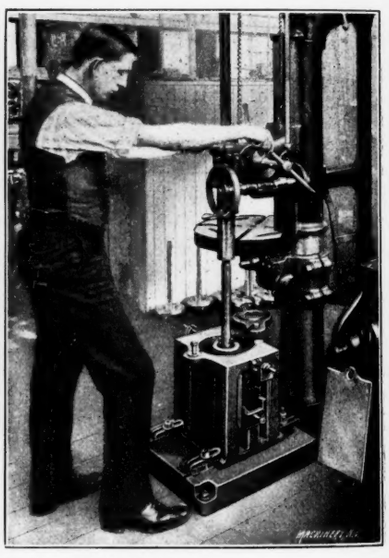


Fig. 17.

Fixture for Boring and Reaming the Turbine Bearings.

Fig. 17 shows the bearing being bored without the use of the guiding bushings, by means of a bar which runs in a step bearing at the base of the jig.

In connection with the oiling arrangements for the bearings, reference should be made to the design of the wheel casing in which the bearings are located. This casing is in two halves, divided on a horizontal plane, and the upper edge of the lower half has an oil groove running around it, as shown in Fig. 2, to catch any drip that may work in between the two halves. The oil is carried down into pockets in the casting, where the ring oilers reach it, and these pockets are piped to

of gaskets which have been cut out by this device. The gaskets used are about 1-16 inch thick, of asbestos board.

To the right of this gasket-cutting table appears a Pratt & Whitney measuring machine, which reads to one-half of .0001 of an inch by means of a microscope. This machine is employed in measuring gages and is not for shop use.

Fig. 13 represents a general view of the inspecting department. All parts which can be readily handled after being finished in the shop are brought here for inspection. They are accurately gone over by special sets of gages, to see that they are interchangeable. The large parts, such as gear and

wheel cases, are inspected out in the shop. After inspection, each piece is stamped with a designating mark, telling who inspected it, to locate the responsibility for any careless inspection. Every part of the turbine is also numbered in the inspecting department, the number being the same for the

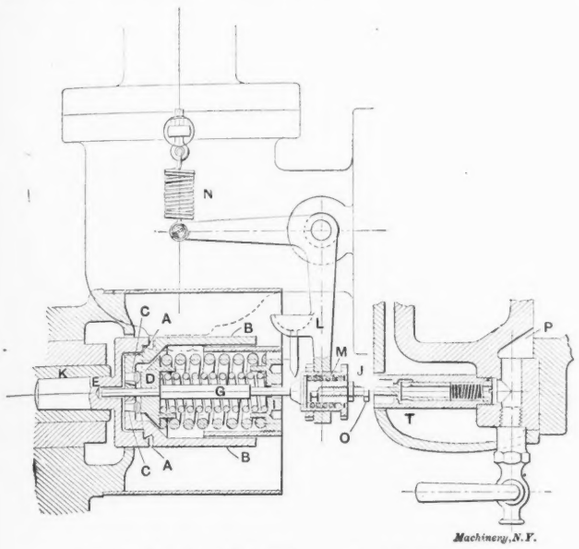


Fig 18 Details of De Laval Governing Arrangement.

same part in the various sizes of turbines, with a letter in front of the number to show the size of the machine. For example, L-429 would represent a 55-horse power gear body, the number "429" being the number of the gear body, and the letter "L" signifying the horse power, which is 55 in this case. The man shown in Fig. 13 kneeling is inspecting with a taper plug gage the hole for the gear shaft in the gear body, which in this case happened to be L-429.

Fig. 20 is a view of the pattern shop, and on the bench in the foreground is an interesting set of patterns used for molding one size of centrifugal pump runner. The particular wheel for which this set of patterns is made is about 24 inches in diameter and is to be used in connection with a 300-horse power pump running at 900 revolutions per minute. At *A* is a half core box inclosing a circular foundation plate on which is the pattern for the spirals located on the inside of the runner. A sweep at *a* is employed for sweeping up the core, which is afterward baked. This makes one-half the core for the inside of the runner; the other half is made on a similar base plate and pattern, shown at *B*. At *C* is the core box for the central hole through the runner, and at *E* is a pattern for one side of the runner, and at its center is the core print for the cylindrical core made in the core box *C*. Pattern *E*, and its mate for the other side of the runner, shown under it, are molded in the foundry, and then the three cores are placed in the mold in the usual manner.

The Governor.

Reference has now been made to most of the principal parts of the turbine, with the exception of the governor and throttle valve which it controls. These are shown in Figs. 18 and 19 respectively. The governor is held in the end of one of the gear shafts by the taper plug *K*, Fig. 18, and is made cylindrical in form, with its outer shell *B B* cut longitudinally into two halves which form the governor weights. These weights are fulcrumed at *A A* and have pins *C C* which press against a collar *D* which takes the thrust of the spiral springs located

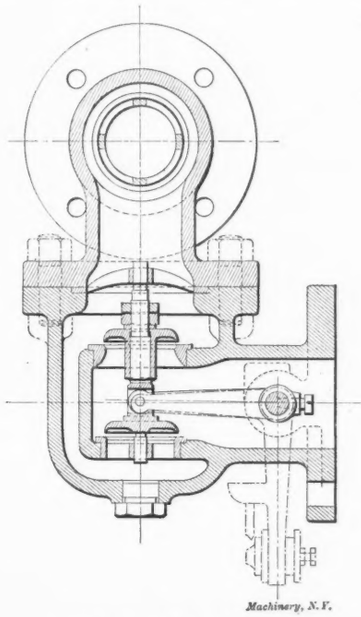


Fig 19. Regulating Valve.

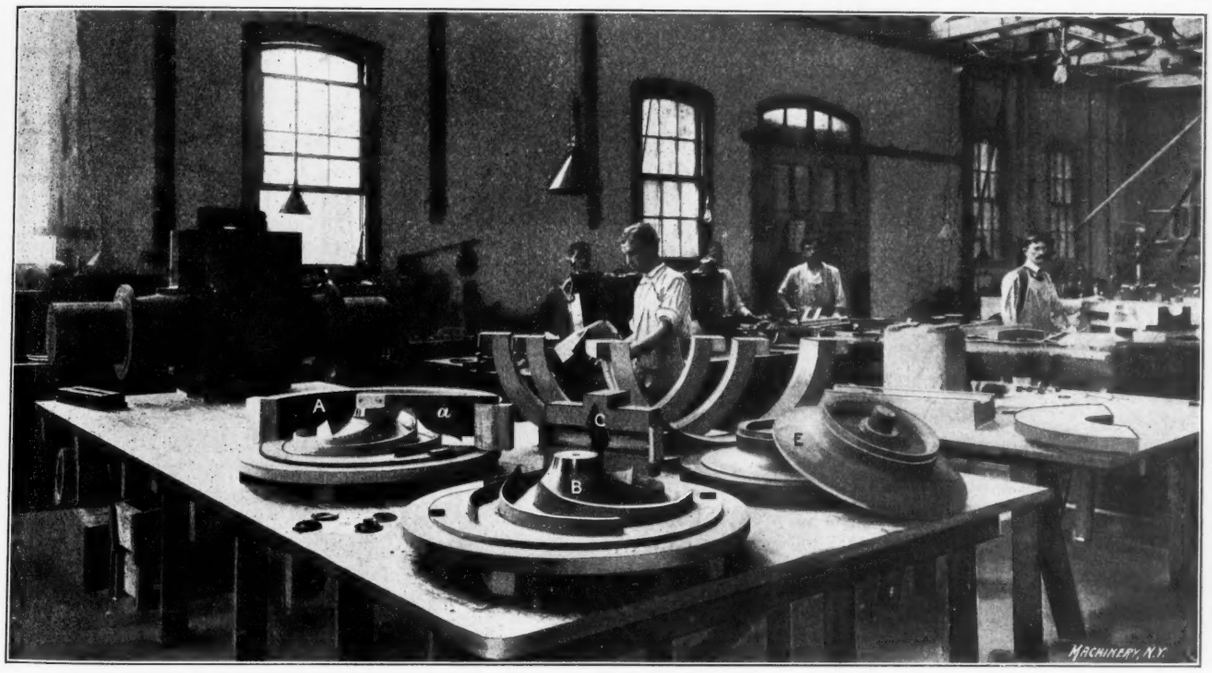


Fig. 20. View in Pattern Shop showing Patterns for a Centrifugal Pump Wheel.

within the governor. The movement of the governor is transmitted through the center spindle *G* to the bell-crank lever *L*, which is balanced by a spiral spring *N*. The shaft supporting this lever passes through the valve casting on the inside of which are a pair of arms connecting with a double-seated throttle valve as shown. In the steam pipe above the valve is a wire cylindrical screen, to prevent any large particles of scale or other material likely to damage the turbine from passing through. It is to be noted that the connection between the center spindle *G* of the governor and the bell-crank lever *L* is a flexible connection, and that at the right is a valve *T*, which connects through the passage *P* with the wheel casing. In case the throttle valve should stick and the turbine speed go up, the governor would have power enough to overcome the pressure of the spring at the connection *H*, and the pin *O* would strike the spindle of the valve *T*, which latter would admit air to the vacuum chamber in which the wheel revolves. This would immediately put an air brake on the wheel and prevent an acceleration of speed. If for any cause the speed becomes excessive this action takes place.

* * *

WOOD PRESERVATION.

As timber becomes scarcer and more costly the importance of its preservation becomes greater. The decay of timber is principally caused by fungi, but bacteria and insects also play a part. Timber will not decay unless it be subjected to three conditions—air, moisture and warmth; if any one of these conditions is absent there can be no decay. Timber submerged under water so that air is excluded will not decay; neither will it decay if continually dry, or where the temperature is uniformly low. But in ordinary use timber is subjected to all three conditions which favor decay, hence the importance to railways of artificial processes for preserving cross-ties, bridge timbers, etc. The Association of Railway Superintendents of Bridges and Buildings in a committee report submitted at the Chicago meeting in October, outlined some of the methods of preserving timber as follows:

Creosoting.—The creosoting process makes use of dead oil of coal tar which is a distillate of coal tar, a product of the manufacture of illuminating gas. Green timber is subjected to a steaming process 200 to 250 degrees F. for several hours in a closed cylinder to liquefy the sap and to solidify the albumen in the cells. After steaming for some hours the cylinder is exhausted to a partial vacuum to expel the liquids from the interior. After this process is complete the cylinder is filled with dead oil of tar at a temperature of about 175 degrees F. and subjected to a pressure of 80 to 100 pounds per square inch to force the oil into the pores. This is sometimes called the Bethell process.

Burnettizing.—In the Burnettizing process the impregnating fluid used is chloride of zinc which is applied in a water solution similar in method to the creosoting process. After treating, the wood must be thoroughly dried to deposit the salt in the cells, but even when this is done exposure of the wood to water afterward will dissolve the salt and leach it away. While the process is fairly satisfactory for ties it is not good for structural timbers and has been practically abandoned by nearly all European railways.

Kyanizing.—In this process seasoned timber is soaked in a solution of bichloride of mercury (corrosive sublimate) which coagulates the albumen. The solution is very poisonous and corrodes iron and steel, hence is unsuited for structural purposes in which metallic fastenings are used. The process is effective, but dangerous to the health of the workers employed.

Wellhouse.—The Wellhouse process also uses zinc chloride as does the Burnettizing process but adds a small percentage of glue. After the timber has been treated under pressure the zinc chloride solution is drawn off and one of tannin is substituted. The tannin combines with the glue and forms an insoluble substance that effectually seals the pores.

Allardyce.—The Allardyce process makes use of zinc chloride and dead oil of tar, the latter being applied last, and the manner of application being essentially the same for both as explained with the other processes.

Boucherizing.—Sulphate of copper in solution is forced into the timber under heavy hydrostatic pressure. Sulphate of copper attacks iron and is, therefore, objectionable from a structural standpoint.

Thilmany.—Sulphate of copper is first used in the Thilmany process and then a solution of barium chloride, but the process has not shown good results.

Hasselman.—The timber is boiled in a solution of copper, iron and aluminum sulphate to which a small quantity of kainit is added. The results in Germany seem to show that the process is satisfactory.

Creo-Resinate.—In this process the timber is first subjected to a steaming process at 200 degrees F. to evaporate the moisture in the cells; the temperature is then gradually increased to 320 degrees F. and a pressure of 80 pounds per square inch. The pressure is slowly reduced to 26 inches vacuum, and then a solution of dead oil of tar, melted resin and formaldehyde is injected. After this process the timber is placed in another cylinder where a solution of milk of lime is applied at a temperature of 150 degrees F. and a pressure of 200 pounds per square inch.

Vulcanizing.—The vulcanizing process of treating timber consists essentially in subjecting it to a baking process in hot air which is heated to a temperature of about 500 F. by passing over steam coils. The heat coagulates the albumen, expels the water from the cells, kills the organisms therein and seals the cells by transforming the sap into a preservative compound. This method is used with success by the elevated railway systems of several cities.

* * *

A QUICK JOB.

The following interesting description of a quick piece of work in replacing a large iron pulley with a wooden pulley, and by this means averting a long shutdown of the plant where the change was made, has been sent us by the Reeves Pulley Company, Columbus, Ind.

On Thursday, October 6, the massive cast-iron main drive pulley, 112 inches diameter, 37 inches face, in the plant of Lafayette Box Board & Paper Co., Lafayette, Indiana, went to pieces.

President Bauer, of the Paper Company, and his superintendent, Mr. Wilson, appreciating the length of time required to get an iron pulley of this size in place, sent their men home, and announced a thirty-day shutdown. They did not know a wooden pulley of this size, and capacitated to handle 600 horse power, could be built, but later in the day Mr. Bauer was persuaded to 'phone Reeves Pulley Company concerning their trouble. The pulley company assured Mr. Bauer that they could furnish him a pulley of the size designated, absolutely guaranteed to carry the load, and the order was placed. Work was commenced on the pulley Friday morning at 7 o'clock, and within eighteen working hours it was completed and en route to its destination. The pulley, accompanied by Superintendent W. S. Jones of the Reeves Company, was taken by Saturday's midnight Pennsylvania Express to Indianapolis, where the Chicago Fast Express of the Big Four was held one hour in order that the pulley might be transferred, and this train in turn delivered it at Lafayette at 3 o'clock Sunday morning. The pulley was here met by a corps of workmen and Superintendent Wilson, who immediately transferred it to the paper plant, where under the direction of Mr. Jones, the installation was completed Sunday afternoon and on Monday morning at 6 o'clock the big mill started as usual.

* * *

A Custodis brick chimney 300 feet high is being built for the New York Steam Heating Company alongside the Manhattan approach of the Blackwell's Island Bridge. It is to have an outside diameter of 29 feet 6 inches at the base, tapering to 17 feet at the top. It will weigh approximately 2,160 tons and will cost $25,000.

* * *

By an error in the engraving, Fig. 1 of Mr. Geo. D. Hayden's letter, "Charts for Forming Tools," in the October issue, .208 was omitted from its place between .192 and .224 under "Given" at the top of the cut. Consequently the quantities to the left as far as the third division space (which was also omitted) are misplaced one space.

ADAMS-FARWELL AUTOMOBILE.

NEW FEATURES AND A NEW TYPE OF ENGINE.

The Adams Co., Dubuque, Ia., have brought out a revolving-cylinder, air-cooled, gasoline motor for automobile use, which possesses many points of novelty. It reverses the ordinary practice, in that the engine cylinders revolve and the crankshaft, which is in a vertical position, remains stationary. The motor is the invention of Mr. F. O. Farwell, superintendent of the Adams Company, and its details have been very carefully worked out during the process of development at the shops of this company. The motor has been tested for a long period under trying conditions and we are informed that its performance has proven satisfactory to its inventor and to the builders, and that it is now placed on the market with the assurance that it will meet any demands that may reasonably be made upon it.

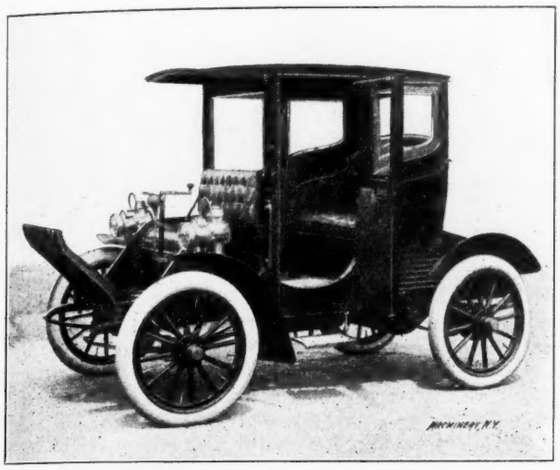


Fig. 1. Automobile with Convertible Front Seat. The Machine can be Controlled from either Seat.

The engine consists of three units, each made up of cylinder, piston, connecting rod, etc. The cylinder castings are bolted together, forming a single rotary element, which acts as a flywheel and is in nearly perfect balance. In a 20 horse-power engine, such as is now built for automobiles, the cylinders have 5-inch bore, the pistons 4½-inch stroke, and the revolving unit, consisting of the three cylinders, pistons, and their connections, weighs only 190 pounds.

The cylinder castings are bolted to a top and bottom cast steel flange which has bronze bushings serving as bearings for the vertical stationary crankshaft. The three pistons are connected to a single crankpin of large proportions by bronze pitmans. Inasmuch as the pistons and cylinders are rotating about different centers, the pistons reciprocate back and forth once during each revolution of the engine.

The light weight of the motor, compared with the usual three-cylinder motor, is brought about by the elimination of many parts found necessary in the engine of the ordinary type. A single central crank case answers for the three cylinders. A single-throw crank, of about one-third the weight of the three-throw crank found in the other type of engine is employed. A single cam operates both inlet and exhaust valves for all the cylinders. Although the engine is light in weight, the rotating parts constitute a flywheel of unusually heavy weight which is conducive to steady running; and the facts that the engine is in so nearly perfect balance and runs on a vertical axis nearly eliminate vibration and adapt the motor especially to automobile driving.

It was determined by experimenting with the engine that the exhaust muffler of the design usually employed could be dispensed with. This is because the rotating cylinders seem to run away from the exhaust gases, as it were, and this action was found to reduce the noise incident to the escape of the burnt gases. The exhaust noise partakes more of the character of the noise of a skyrocket than of the report of a gun. Auxiliary exhaust ports are employed which reduce the pressure before the gases finally discharge to the atmosphere, and we are informed that at low power the exhaust is noiseless, while at full power there is less noise with this system than in the case of an engine of the usual construction working at full power.

Another unlooked-for result brought out in experimenting with the engine was that centrifugal force served to close the valves and that this force was in direct proportion to the requirements. The higher the speed the greater the force and the greater the need for a stiff spring or force to open the valve. The springs actually used are made of light piano wire and are useful only to close the valves in starting the engine when the centrifugal force at the slow starting speed might not be sufficient to overcome the resistance of cold lubricating oil on the valve stems. After the engine is started and has become warmed up the springs are not needed.

One of the most advantageous results of the moving cylinder principle is the effective air-cooling accomplished. The cylinders are cast with longitudinal external ribs, to provide a large radiating surface and their rapid rotation draws in the air at the center of the casing which incloses the engine and expels it with a considerable velocity at the periphery, or ends of the cylinders. The air is continuously in contact with every part of each cylinder, and there can be no hot spots in the cylinder walls due to unequal circulation of the air, such as is effected by a fan driving the air against only one side of a cylinder or group of them. The cylinders are found to keep cool and work well in warm weather, and there is nothing to freeze in cold weather.

The foregoing briefly summarizes the most prominent features of the new motor, resulting from the rotating cylinder construction. The inventor has carefully worked out other features, however, which, although they could be applied to engines of other forms of construction, seem to be of quite as great interest to the automobilist as the details already outlined. First of these in importance is that the speed of the motor is controlled by a variable compression system. Ordinarily the speed of an automobile equipped with this engine

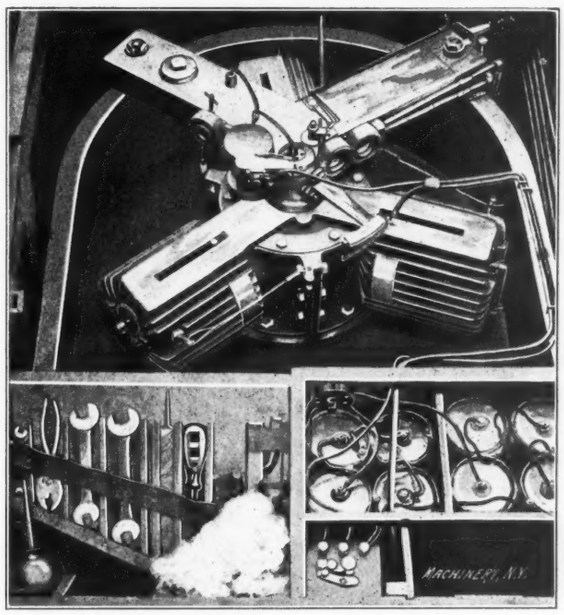


Fig. 2. View of Motor, with Rotating Cylinders, showing it in position in the Vehicle.

may be controlled by changing the speed of the motor, just as in a steam engine; but a speed gear is provided that can be used to pull the machine out of a rut or in climbing an exceptionally steep hill, if found necessary. In the compression system used that part of the charge not needed to give the motor the required power is allowed to escape back by the inlet valve, which is mechanically held open for a part of the compression stroke; that part of the charge so escaping being drawn in by another cylinder. The mechanism is so designed that that part of the charge rejected by any cylinder is first used in the succeeding cylinder, before additional gas is

drawn through the carbureter. There is therefore no waste of gas. When the maximum power is required the inlet valve is closed at the end of the suction stroke and the full charge is compressed to about 95 pounds per square inch. When minimum power is wanted, the inlet valve is not closed until the completion of the compression stroke, and an exceedingly small part of the charge is retained and ignited at atmospheric pressure, giving a gentle expansion.

With this system of control the chauffeur has nothing to do with the point of ignition of the charge by the spark. Instead, the spark is controlled automatically by a device connected with a centrifugal governor and fires the charge at the point producing the highest efficiency at all speeds. It also automatically changes the length of contact of the primary circuit for different speeds, with a view to saving the battery current and contact breaker points. At a speed of 150 revolutions or less the contact is for a period occupying 1-36 of a revolution of the engine; and for a speed of 900 revolutions, the period is during 1-12 of a revolution.

The carbureter is also entirely automatic at all speeds, no attention being required after once adjusting. The proportion of air and gasoline always remains the same, but the quantity of the mixture varies according to the power required and the position of the variable compression cam.

The oiling of all parts of the motor is cared for by a positive-feed oil pump. This consists of a circular barrel in which are four cam-actuated plungers. The barrel is positive-

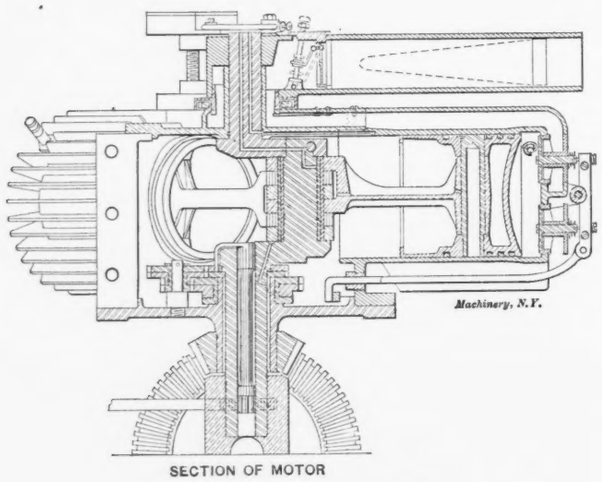


Fig. 3. Sectional Elevation of Engine.

ly driven by a worm gear and will deliver one drop of oil to each of four tubes, carrying the oil to different parts of the engine every 100 revolutions. Two of these tubes lead to a distributing channel in the upper end of the crankshaft and oil the top of each cylinder; one tube leads to the upper end of the wristpin and from thence to the lower crankshaft bearing, a surplus accumulating in the crankcase, which lubricates the valve-operating cams and gears. An opening on each side of each cylinder admits oil from the crankcase to the cylinders, thus oiling each cylinder and piston at three equidistant points. The fourth tube is an extra, and usually is turned to deliver its oil back into the tank. The tank is close to the engine where it is kept warm in the winter time.

Fig. 2 is a view of the motor as situated in the rear of an automobile body. From this position every part of the motor liable to require inspection is readily accessible and exposed to view. Also, the tools required for adjustments, the batteries, spark coils, etc., are all close at hand. In Fig. 1 is shown one of the latest designs of automobile body used by the Adams Company. The fact that the motor is located under the seat makes it possible to adopt the style of convertible carriage illustrated, by which a second seat in front is available in front of the main or fixed seat. The sides and top are removable, and the motor and car can be controlled from either the front or rear seat. The novel features of the car and motor are subjects of patents granted or pending in this and foreign countries.

A MODERN PATTERN SHOP AND ITS SYSTEM OF HANDLING PATTERNS.

The new pattern building of the B. F. Sturtevant Co. at Hyde Park, Mass., is divided midway of its length by fire walls inclosing stairs, elevators, etc. One-half the building, with stories respectively 17 and 15 feet, is devoted to the flask and pattern making rooms, while the other half, provided with intermediate floors, making four in all, is utilized for pattern storage. An illustration of the exterior of this pattern building has previously appeared in these columns in connection with a description of the new Sturtevant foundry.

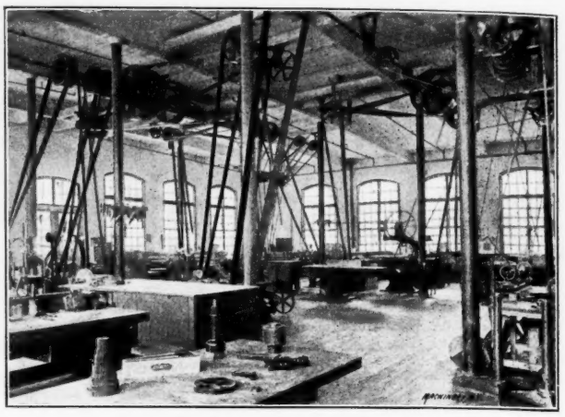


Fig. 1. View in Flask Shop.

The flask-shop measuring about 60 feet by 80 feet is equipped with band, cross-cut and splitting saws, boring machines and lathe, all driven by a 10 horse power Sturtevant motor suspended from the ceiling. The industrial railway runs directly into this room from the foundry, across a distance of about 40 feet and together with an overhead transfer track reduces to a minimum the cost of handling flasks. The lumber for their manufacture is unloaded from cars directly in front of the building. This room includes the metal pattern-maker's department equipped with the necessary machine tools. Adjacent thereto is the locker, wash and toilet room for the building.

Immediately above is the pattern shop, abundantly lighted upon three sides and equipped with a full complement of tools. All the power machines are operated by two 10 horse power Sturtevant motors, both being required for ordinary work, but one always serving as a possible relay in case of accident.

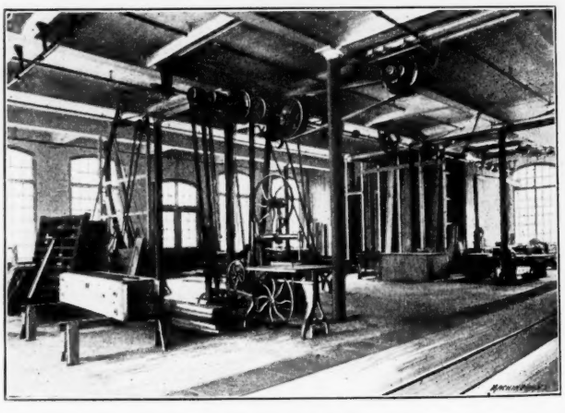


Fig. 2. Pattern Shop.

The benches which accommodate two men each and measure 2 feet 6 inches in width by 16 feet in length are so arranged along the sides of the building that the men all receive a left-shoulder light. Behind each bench is a working table 4 feet wide by 16 feet long. The benches are supported by cast iron legs of special design which were built by the Sturtevant Co.; the same design is used throughout the plant. They are equipped with Emmert vises and their tops are of heavy maple plank. A drying chamber for glued work is provided which receives warm air through the general heat flue from a Sturtevant heating apparatus below.

The first floor of the pattern storage end of the building is of concrete and is designed for the keeping of heavy cast iron patterns. It is served by an industrial railway and turntable which permits of transfer to the elevator and thence to other floors. Communication between the pattern shop and storage department is direct, while the fire risk is reduced to a minimum by a double system of fire doors. Around the pipe columns which support the floors are clamped the pattern shelving brackets which are adjustable to any height. Shelves on the walls afford excellent storage space for the smaller patterns.

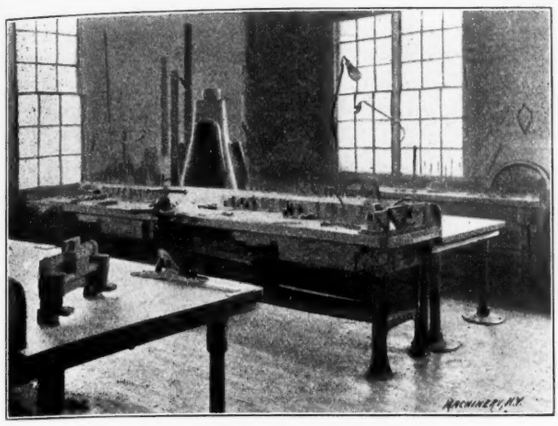


Fig. 3. View of Pattern Shop, showing Benches.

In connection with a description of this shop, the system of handling patterns is of interest. New patterns are numbered consecutively upon the drawings as made. Patterns for gray iron castings take a number without prefix. Patterns for brass castings take a number preceded by 0, those for steel have the number preceded by 00, and so on with a different prefix for each material. The numbers are taken out by the draftsmen in a blotter having columns for data, pattern number, name of pattern and drawing number. This record is afterward transcribed into the "Pattern Record" book by the record clerk in the drafting room.

Fig. 4. Pattern Storage Room.

At the time of taking out a new pattern number a pattern cost card is filled out. This is sent with the drawings to the foreman of the pattern shop and is an order for him to make the pattern described. The time is kept in the pattern shop and entered on this card, as is also the record of stock used. When the pattern is completed, it is inspected by the pattern shop foreman who signs cost card and enters date completed. The pattern is then sent at once to the pattern storage, which is under the supervision of the pattern foreman, and the pattern cost card is returned to the drawing room by the next messenger. The record clerk in the drafting room figures the total cost of the pattern, writing on the card the cost of the labor, stock, etc., and giving the totals. The card is then filed away according to its number. When any work other than pattern work is done a record is kept of the time and material and the pattern shop is given credit. These records give the amount of material and labor chargeable to expense, to which are added a depreciation and fixed charges. The whole is then distributed as a percentage on the hours of pattern labor.

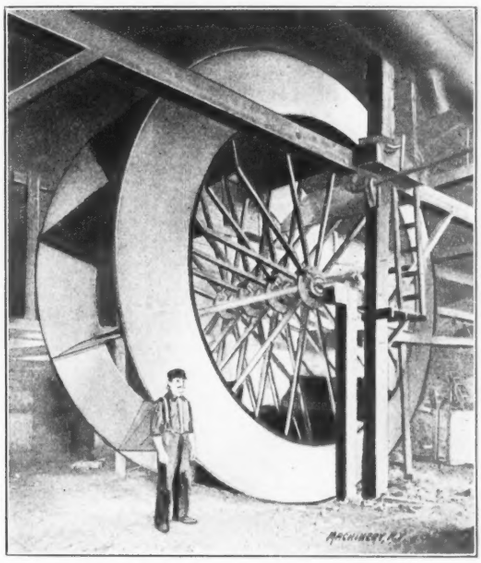
When the patterns are delivered to the pattern storage department proper locations are assigned and records thereof made upon cards, one for each pattern. These cards are filed in the order of the pattern numbers. Four figures, with the addition of a letter, are in every case sufficient to locate a pattern. A given location, for instance, may be 2125B; that is, it is upon the second floor, as shown by the first numeral "2;" it is in the twelfth row of shelves and the fifth division of that row, as shown by the succeeding numbers "12" and "5;" and on the B level, the floor level being designated A, and the letters B, C, D, etc., indicating the shelves in their order above.

When the foundry foreman receives an order for castings from the office he issues an order to the pattern storage department. The pattern storage keeper on receipt of same refers to a card index of patterns giving the location of pattern desired. The foreman's order is then attached to the pattern and delivered to the foundry. A metal clip placed upon the card in the card index belonging to the pattern sent out, indicates the pattern is out. When the casting order reaches the foundry a copy is sent to the clerk of the cleaning room, who daily records on the back the number of good and bad castings made from the pattern and keeps the molder informed as to the number of castings required to complete the order. When the required number of castings are made the pattern is returned to the pattern storage, and the metal clip taken from the index card.

* * *

LARGE MECHANICAL DRAFT FAN.

In the September number was published a contribution describing the large ventilating fan of the Albespeyre Tunnel of the Langogne-Alais line running between the Atlantic and Mediterranean. This called forth a communication from the Garden City Fan Co., of Chicago, in regard to a large fan for a mechanical draft plant of 500 H. P., showing that the latter is larger than the foreign article, and that we are still sustaining our boasted reputation for big things. The Garden City fan is 20 feet in diameter by 9 feet wide at the periphery, whereas the Albespeyre fan is 6 meters, or 19.7 feet, while the width is 2.5 meters, or 8.2 feet. The weight of the American wheel is 5 tons without the shaft, which is 9 inches in diameter and with its coupling weighs 4,500 pounds, making a total weight of 7½ tons on the journal bearings. The fan wheel was incased in a ¾ housing of steel measuring 36 feet from the bottom of the bed to the top of the housing, and 26 feet in length. The illustration herewith is from a photograph taken of the fan when in the process of erection in the factory. It is believed by its makers to be the largest fan ever built.



Fan Twenty Feet in Diameter for Mechanical Draft Plant.

THE HAMILTON-HOLZWARTH STEAM TURBINE.

It has been known for some time that the Hooven-Owens Rentschler Company, Hamilton, O., were developing a steam turbine and that one was being built by them for the St. Louis Exposition. This first machine is now in operation and is direct-connected to a 1,000-kilowatt Bullock generator. The turbine is of the compound impulse type in which there is a series of impulse wheels, each wheel in a separate compartment and driven by jets of steam directed against the wheel buckets by suitably-shaped guide vanes.

The illustrations herewith give a general view of the turbine and show some of the features of construction. For units of 750 kilowatts and upward, the rotating body is divided into two parts, the high- and low-pressure turbine. Smaller turbines are built with the parts inclosed in a single casing. The turbine casings and pedestals for the bearings and the generator are mounted upon a single bedplate, and all steam, oil, and water piping, including the steam inlet, are within and below the bedplate. The steam enters through a separator and passes through the main inlet valve and the regulating valve, all below the bedplate, to the head of the high-pressure turbine. From the steam channel of this head the steam flows through the first set of stationary vanes, forming a complete annulus of steam channels, which direct the steam at the proper angle against the wheel blades, and allow the steam to expand to the lower pressure in the compartment in which the first wheel rotates.

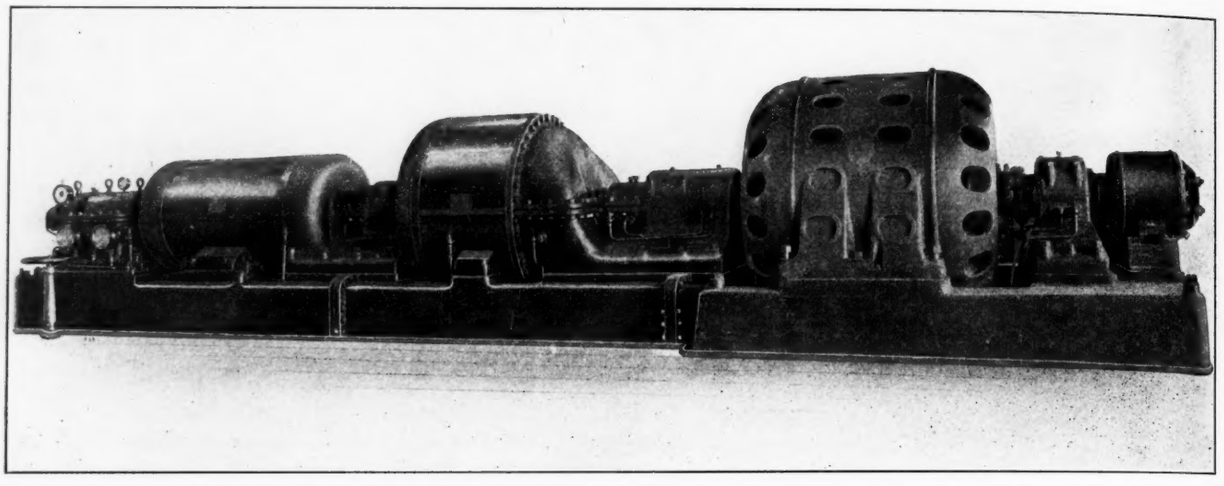


Fig. 1. One Thousand K.W. Steam Turbine built by the Hooven, Owens, Rentschler Company, Hamilton, O.

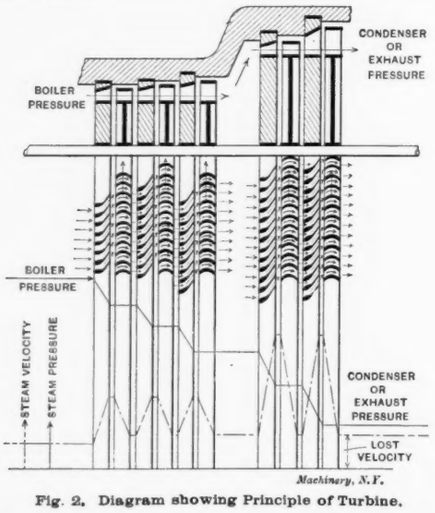


Fig. 2. Diagram showing Principle of Turbine.

From the last running wheel of the high-pressure turbine the steam is led through receiver pipes to the front head of the low-pressure casing, or if there is only one casing, immediately to the condenser. In the low-pressure turbine the steam is distributed in the same manner as in the high-pressure turbine. The low-pressure front head, however, has an additional nozzle through which live steam enters for use in case of overload. The design is such that this steam, which is controlled by the governor, exerts no back pressure upon the steam from the high-pressure turbine. On the contrary, it works like an injector, sucking the steam through the first stationary vanes of the low-pressure turbine. The disks of the low-pressure turbine have guide vanes all around their circumference, as in the high-pressure turbine, and the steam flows through them in a full cylindrical belt, interrupted only by the guide vanes.

The scheme of the turbine and the action of the steam are illustrated in the diagrammatic sketch, Fig. 2. The steam passes through the turbine in the direction indicated by the arrows. The smaller diameter at the left represents the high-pressure turbine, and the larger diameter at the right the low-pressure turbine. The stationary vanes in each disk gradually increase in height, while the vanes are made higher in the successive wheels to accommodate the increasing specific volume of the steam. The wheels receive no unbalanced steam pressure in an axial direction, because the impact of the steam upon the buckets and its reaction in leaving the buckets are equal. If, as in the Parsons turbine, the steam acquired additional velocity in passing through the wheel channels by expanding in these channels, the reaction would be greater than the impact, which would produce an end thrust. In the Hamilton turbine the pressure is the same on both sides of each wheel. The diagram in the lower part of the sketch shows the changing steam pressure and steam velocity so plainly as to need no further explanation.

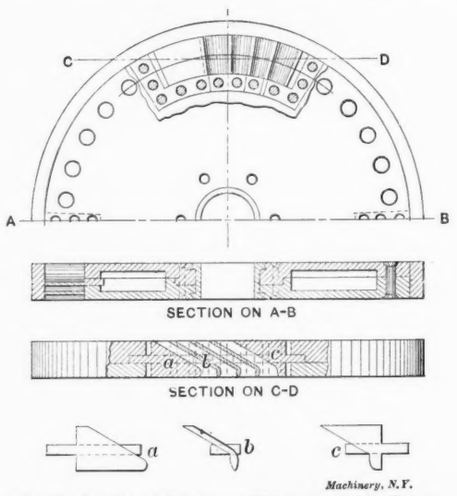


Fig. 3. Details of Stationary Disks and Guide Vanes.

In Figs. 3, 4, and 5 are shown certain details of construction of the turbine. Fig. 3 illustrates the features of the stationary disks, which are built up of two side pieces riveted together. Each vane is a separate piece held by a projection

at its lower end, which fits in an annular groove between the two disks at their periphery. The vanes are of drop-forged steel and are secured by rivets. After they are in position, their outside ends are ground and a steel ring is shrunk on. At *a*, *b*, and *c* are shown three forms in which the drop-forged vanes may be made. In the turbine, as now constructed, however, the vanes extend around the whole periphery, so that the type shown at *b* is the only one required.

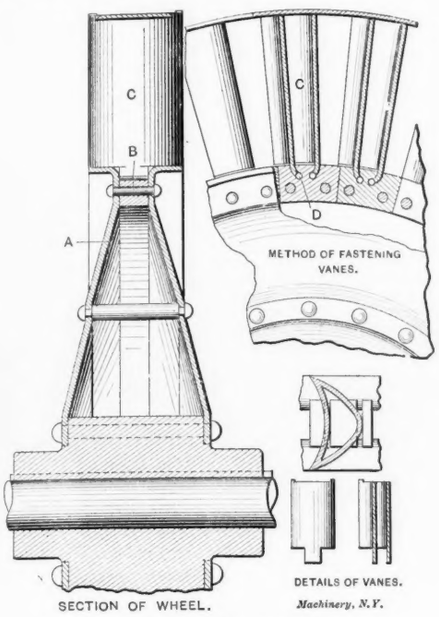


Fig. 4. Details of Turbine Wheel.

Next in importance to the guide vanes and the disks which hold them, is the construction of the rotating wheels, in Fig. 4. These wheels are as light as possible, with cast steel hubs to which are riveted conical disks *A*. There is a space between the disks at their periphery in which are riveted short steel segments *B*. The vanes are attached to these segments, as shown in the sectional view at *D*. The vanes are formed with lips extending downward, and these lips are enlarged at their ends to fit into the enlarged bottom portions of cross channels in the segments *B*. The vanes are so designed that the passages through the wheels have a uniform area from beginning to end, and they are made hollow to reduce their weight. On the outer ends of the vanes a thin steel band is shrunk to give an outside wall to the steam channels. The vanes are milled on both edges to give correct influx and efflux angles.

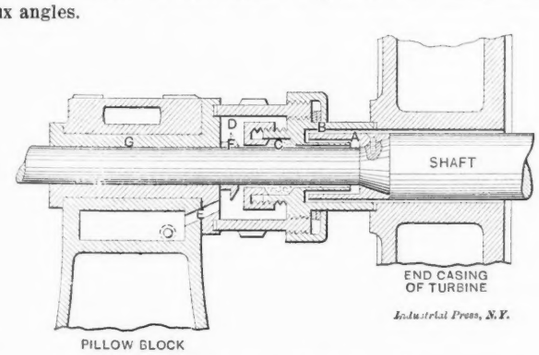


Fig. 5. Gland and Bearing for Shaft.

At Fig. 5 is a sectional view of the bearing and stuffing box for the shaft at the point where it passes through the end of the turbine casing. The shaft is turned to a smaller diameter at its end and runs in a bushing *G*, having a flange bearing against the inner side of the pillow block. At *A* is a cylindrical piece attached to and rotating with the shaft. This piece projects into an annular groove in the piece *B*, but it does not completely fill the groove and a circuitous passage is formed through which the steam must pass before reaching the stuffing box *C*. The object of the passage is to provide condensing surface so the steam itself will not reach the packing. The joint at the stuffing box is thus practically a water-locked joint.

To prevent the oil from working into the turbine a bushing *F* is attached to the shaft which throws off the oil into the space *D* by centrifugal force, where it drips down through a channel *E* into a compartment in the pillow block. Any water escaping through the stuffing box is also collected in the same compartment. The bearing is oiled by a forced oil system, the oil being supplied to the bottom of the bushing.

The high-pressure and low-pressure turbines each have a separate shaft connected by a flexible coupling, and the generator also has its own shaft driven by the turbine through a flexible coupling.

The couplings are a modified form of the familiar disk coupling, having clutch teeth projecting from the face of each disk. The teeth in this case, however, are laminated, which gives them both the necessary strength and flexibility. They are built up of thin steel plates, and the laminated teeth of one disk fit in the spaces between corresponding pairs of teeth in the mating disk.

The governor is of the spring and weight type, adapted to high speed, and controls the turbine by throttling the steam. The throttling takes place at a single balanced valve instead of at the nozzles in the first disk. The governor is constructed on a relay system on the following plan, illustrated in Fig. 6:

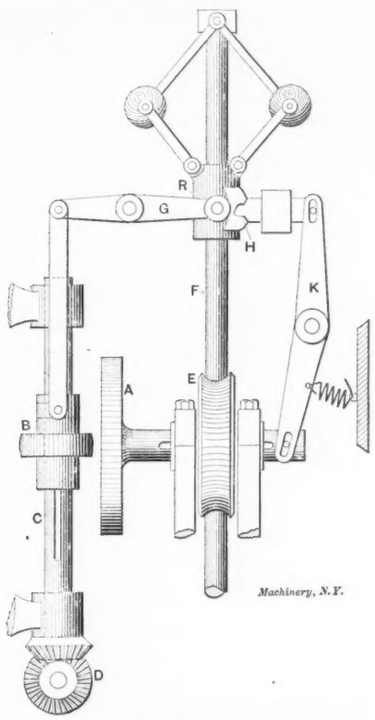


Fig. 6. Diagram of Governor Mechanism.

The regulating valve is controlled by means of a friction disk drive, in which the edge of a small disk or roller is in contact with the face of a continually rotating disk. This disk is driven by a worm and wormwheel from the shaft which operates the governor. In the illustration, *A* is the friction disk, *B* the roller, *C* the splined shaft with which the roller turns, but upon which it is free to slide; *D*, bevel gears connecting shaft *C* with the throttle valve; and *E*, a wormwheel driving disk *A* by means of a worm on shaft *F*. At normal speed the governor sleeve is in mid position and roller *B* is at the center of the disk. If the turbine speeds up, however, the governor sleeve will rise, carrying with it the right-hand arm of lever *G*, which will move the roller *B* a corresponding distance downward. At the same time the cam *H* will be thrown to the right by contact with the roller *R* upon the governor sleeve, and this, by means of lever *K*, will move the disk *A* and its shaft to the left in contact with roller *B*, thus imparting a rotary motion to the shaft *C* and closing the throttle valve the necessary amount to bring the speed of the tur-

bine back to normal again, when the several parts will assume their first position. If the speed of the turbine decreases, the action of the mechanism will be entirely similar, except that the roller *B* will be raised instead of lowered and brought in contact with the friction disk at a point above its axis. The disk will therefore rotate shaft *C* in the opposite direction, opening the throttle valve instead of closing it as before. Other features of the governor are that when the angular velocity of the turbine reaches a point 2½ per cent. higher than normal, the governor shuts off steam entirely. Also if the angular velocity falls below a certain percentage of the normal speed, the friction disk is drawn back so that the valve-operating part of the mechanism is inoperative. The methods of accomplishing these results are not shown in the sketch.

This turbine is known as the Hamilton-Holzwarth steam turbine. It is made under patents of Hans Holzwarth, assignor to the Hooven-Owens-Rentschler Company.

* * *

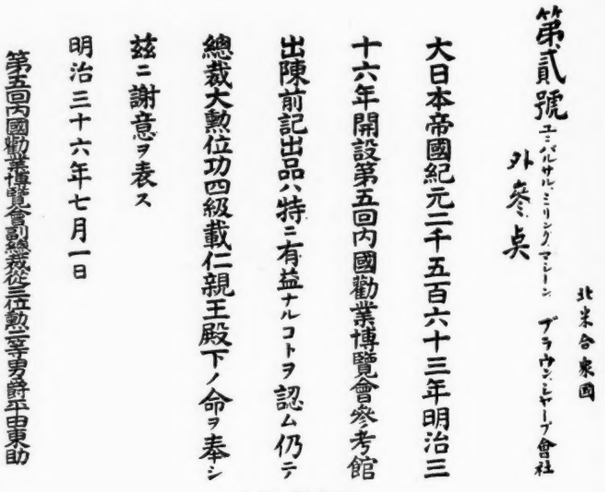
CHAIN DRIVE IN A RUBBER MILL.

The conditions of power transmission in rubber mills are probably as severe as found in any class of manufacturing, save perhaps in rolling mills. The nature of the work is very intermittent, causing sudden shocks on the transmission gears; the machines may at one moment be taking the maximum power requirement and in a few moments the power requirement decreasing to zero. For this reason the use of chain drive in the works of the Vulcanized Rubber Co., at Morrisville, Pa., is of much interest because of the severe duty imposed upon it. A prominent mechanical engineer of New York city who rebuilt these works some two years ago, investigated the merits of chain drive and finally adopted the chain manufactured by the Morse Chain Co., of Trumansburg, N. Y., as the one he considered best for the particular service in view. It was used for transmitting power from the main shaft to the line shafts, for transmission from electric motors to line shafting, and to individual machines and tools. The main shaft in the old mill was driven by a spur gearing direct from the engine as is the usual practice in rubber mills, on account of the necessity for a positive drive. In the new mill, however, it was desired to get rid of this method of driving on account of the noise made by the gears, and because clear alleys on each side of the rubber rolls were desired. Moreover, it was desired to group all the engines in one engine room. The plans called for two independent 200 horse-power Corliss engines driving a jack-shaft, and thence the main line of shafting. One engine was a relay to be used in case of breakdown or during repairs. To drive through belting, while possible, was not done because at least 24-foot centers would be required which would make necessary a larger engine room. The reduced center distances possible by the use of chain drive enabled the floor space in the engine room to be reduced some 750 square feet, which amounted to a saving in the cost of the building of $1,000, making the net saving between the cost of the chain and belt drive about $500 in favor of the chain. One engine is connected to the jack-shaft, which is distant from the fly-wheel shaft 7 feet center to center, and which carries other sprocket wheels for connection to the auxiliary engine some 10 feet away. In case one engine gives out, the driving chains are uncoupled and placed on the other sprocket wheels so as to drive with the auxiliary engine. The jack-shaft is connected to the main shaft with Morse chain running on 14-foot centers, making the total distance from the engine to the main shaft about 21 feet. These chains run about 1,150 feet per minute and after a year of constant service, show practically no wear on the rocking joint surface. Besides the main chain drive there are 40 motor drives operating principally individual tools in connection with the work in the factory, and a few of them driving blowers and pumps. The engineer reports that the cost of individual drives from the motors is more with the chain than for leather belting, but that the chain has most decided advantages on account of its positive speed ratio, less space required, shorter center distances, higher efficiency, and greater durability. The efficiency claimed by the makers for a chain is about 99 per cent., and, under the conditions found, the engineer could hardly have expected to have obtained an efficiency of much over 94 per cent. with leather belting. Hence he calculates that the increased cost of the chain drive will be more than offset by the saving in power alone, to say nothing of the other advantages just enumerated.

* * *

A JAP DIPLOMA.

The cut below is a reproduction of a diploma, written in the Japanese language, which the Brown & Sharpe Mfg. Co., Providence, R. I., recently received for an exhibit of some articles of their manufacture which they had at the Japanese Exhibition. The translation of the Japanese characters is as follows: "We, by the order of H. I. H. the Prince Kotohito,



A Jap Diploma.

President of the Fifth National Industrial Exhibition of Japan, hereby express our thanks for the valuable display of the above mentioned articles, which proved to be special object lessons to our people, in the Foreign Samples Building of the Fifth National Industrial Exhibition held in the 36th year of Meiji." (Signed) Baron Tosuke Hirata, Vice-President of the Fifth National Industrial Exhibition.

* * *

Photography is one of the most valuable means of record, and its use for this purpose is extending into all departments of engineering and mechanical work. A photograph tells its story at a glance, and when dated and supplemented with written notes a series of views makes the best possible record of progress. The cost of making photographs with a proper equipment is not a great expense, and any bright young man can learn to make exposures, develop the negatives and make the prints, in a few days. Some large shops use the camera extensively to show the rate of progress of work, the pictures being taken every few days. To insure accuracy as to the dating it is a practice to set up a small blackboard in the foreground with the date chalked in large letters thereon. Whenever a special job is done a picture should be taken of the set-up of the machine, and of the successive steps taken in the operation. It will often be of material assistance afterward to be able to show just how a certain job was done and what tools were used. In a case of accident or breakdown a record may be of great value, and cases are known where a good picture has been the principal and deciding evidence in a damage suit. With a high-grade lens tracings can be photographed in greatly reduced scale without distortion, and prints made from the negatives may be used in the shop much more conveniently than the large cumbersome blueprints. Lines and dimensions, although of microscopic size, will stand forth with great distinctness even though the tracing is photographed to a scale, say, one-sixth or less of the original size. In fact the usefulness of the camera in the average shop is only limited by the enterprise of those responsible for its application.

CURRENT ITEMS.

The seventh session of the International Railway Congress will be held at Washington, D. C., May 3-14 inclusive. This congress is composed of eminent railway men of all countries, and it meets only once in five years. The coming meeting at Washington will be the first ever held in this country, and it is expected to be of great interest, because of its international scope and representation to American railway men. Unusual efforts will be made by the American committee in charge of the arrangements, to make the meeting a successful one in the matter of exhibiting American railway appliances. The opportunity is one never before experienced by American railway manufacturers for the exploitation of their wares before so many representatives of foreign railways, who are eager to become acquainted at close range with American railway practice. The secretary of the American section of the International Railway Congress is Mr. W. F. Allen, 24 Park Row, New York; the secretary of the committee having charge of the exhibit of railway appliances is Mr. J. Alexander Brown, at the same address.

A meeting of the committee appointed by the American Society for testing materials on standard specifications for iron and steel was recently held in this city. Every step toward the adoption of engineering standards is to be commended, in view of the great convenience of such standards to engineers engaged in constructive work. We think no one would advocate carrying standard construction to the point where individuality would be eliminated. That this point would ever be reached is quite improbable, however, since it has been only with great effort on the part of a few enthusiasts that we now have such few standards as screw threads, pipe threads, etc., and standard methods of testing engines and boilers. Practically the only standard in engineering work up to date is the one adopted two or three years ago by the engine builders and electrical engineers for direct-connected generators, and as far as we know this has not come into very general use.

It is even more important to have standard specifications for materials of construction, upon which safety of life and limb depends, than for any other branch of engineering work. The committee having the matter in charge has already decided upon certain standards for test pieces after conferring with the committee of British engineering standards who are working along the same lines. The investigations of the committee and their recommendations are to extend also to the importance of standard specifications for structural material.

The West Side Young Men's Christian Association of New York City is now offering a course in Advanced Machine Design. This is not merely a course in drawing, but a thorough course in designing. To any young man residing in or near New York City, the course which the association offers will be a rare opportunity. It will consist of the working out of a number of problems, chosen in such a way as to be as helpful as possible to each student. These problems will be worked out by the students just as they would be in a regular drafting-room. Rules and formulas will be used in determining the dimensions of the various parts of the machines. Formulas will be taken, as far as possible, from the standard handbook, such as Kent and Suplee. Only such theory will be introduced into this course as is necessary. This work is intended for men who have not had a technical education, and will be made very practical in its character. The course will not be as extended as in a four-year technical school, but the work will be of inestimable value to men who desire a working knowledge of machine design, at a minimum expense of time and money. Only a nominal tuition fee will be charged. Professor Amasa Trowbridge of Columbia University is to have charge of the work. He is an engineer of wide experience, as well as an able instructor. Each student will receive personal instruction, and, as a knowledge of drawing is required for admission to the course, very rapid progress should be made.

LAUNCHING OF THE CONNECTICUT.

The United States battleship *Connecticut* was launched at the New York Navy Yard, September 29, in the presence of a vast throng of invited guests in the yard, and of a greater multitude on the surrounding piers and every point of vantage from which a view of the vessel could be seen; the promenade of the new Williamsburg Bridge was crowded from shore to shore. She is the first battleship to be built by the Government in several years, and is the largest built by any government to date. The *Connecticut*, with full equipment, will have a total displacement of 15,000 tons, and she and her sister ship, the *Louisiana*, now building at Newport News, will be the two heaviest battleships afloat. The launching was a complete success, passing off without hitch of any kind. The launching ways were greased with 8,500 pounds of tallow, which had been carefully boiled and filtered to remove all grit, to the end that the immense steel hull weighing 6,800 tons should encounter the least possible resistance during its movement into the water. The *Louisiana* was launched by the Newport News Shipbuilding Company some weeks before, and there is a great rivalry between the Navy officials and the private concern to see which can turn out a completed ship first. The outcome will to a large extent affect the future of battleship building in the navy yards. If it is shown that, working under the handicap of an eight-hour day, the navy yards can build battleships as quickly and cheaply as the private concerns, it is probable that most of them will be built by the Government in the future. The large and finely-equipped machine shops of the New York Navy Yard, costing over a million dollars (described in the July, 1902, issue of MACHINERY) were erected for the express purpose of building marine engines and other equipment for new naval vessels. The *Connecticut* is the first vessel built since the new shops were completed.

Further announcement is made of the progress of the work of the committees in planning the Carnegie engineering building. The programme of competition given to competing architects outlined that the auditorium, which is a central feature of the building, should have such capacity only that the voice of an orator or speaker should be distinctly heard in every part of it. It was considered useless to make the auditorium so large that discussions by untrained speakers should become merely a dumb show of moving lip and gestures. It was finally decided that an ordinary speaker could be heard if the audience did not exceed 1,000 on the floor, with the possible addition of 500 in a gallery. There are also to be smaller auditoriums having a capacity of 250 and downward, for monthly reunions.

The main auditorium is to be on the street floor and above this and the smaller meeting rooms will be the office floors, one for each of the societies, with reception rooms, etc. Above these there may be additional floors, if the funds are sufficient. On the top floor which will probably be the twelfth floor from the street will be located the consolidated libraries and the reference and reading rooms. Thus located in the building it will not only be more quiet, but it will be in the better air, above the fly line and will be lighted from the roof. Already the societies are taking up the question of organization and management of the building after its completion.

The engineers' club, which is to occupy a building adjoining that of the three engineering societies, and is to form the social part of the organization, will manage its own building independently as soon as it is completed.

* * *

Marine propeller wheels are made right- and left-handed, and the direction of the helix corresponds to that of right- and left-handed screw threads. In other words, the top of a left-handed propeller wheel turns over to the left as the observer stands behind it, when the boat is being driven forward, and right-hand wheel contrariwise. From the point of view of an observer in the boat the water may be regarded as a stationary nut and the direction of rotation in driving ahead is the same as that of a screw thread when turning out of its nut, that is, clockwise for a left-hand screw and contra-clockwise for a right-hand screw.

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NOVEMBER, 1904.

NET CIRCULATION FOR OCTOBER, 1904,—22,437 COPIES.

MACHINERY is published in four editions The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets

THE CONNECTICUT STILL SAFE.

The authorities at the New York Navy Yard have discovered a veritable "mare's nest" in certain reported attempts to scuttle the *Connecticut*, which was recently launched. While any attempt of this character must mark the perpetrator as a dangerous man and a traitor to his country's interest it nevertheless appears that much more importance has been attached to the discoveries than they merit. The attempts to wreck or injure the vessel, if such they were, gave the newspapers material for many columns of sensational matter, but it seems absurd to give the incident the wild-eyed attention that it has received, because the attempts were so weak and puerile as to be scarcely worthy of attention except as indicating the spirit of the perpetrator. In the natural course of events they could have caused little trouble. In one case, it is alleged that four rivets were drilled through longitudinally so as to make holes one inch or less in diameter through each rivet. "A small leak will sink a ship," but we should not anticipate any serious results from such a trifling leak as caused by four one-inch holes in the bottom of a newly-launched vessel, which must necessarily be carefully inspected from stem to stern immediately following the launching to stop small leaks and to discover other defects that always develop. Another alleged attempt was the fixing of a 1⅜-inch bolt in one of the launching ways so as to stop the vessel or to rip off plates while on its progress to the water. It is absurd to imagine that such a trifling obstruction as a bolt of this diameter would materially impede the progress of a vessel weighing 6,800 gross tons or over 15,000,000 pounds when once it was under way. It is reported that the vessel acquired a speed of fully fifteen knots per hour by the time she reached the water. Allowing that it was only ten knots, a simple calculation, using the well-known formula for kinetic energy $E = \frac{1}{2} Mv^2$, shows that the energy of a body weighing as much as the *Connecticut* when moving at the rate of ten knots an hour or seventeen feet per second, is over 68,000,000 foot-pounds. This enormous force would be sufficient to shear off nearly 1,000 steel bolts 1⅜ inches in diameter if they were firmly fixed, but a bolt driven into a timber would simply bend over out of the way, and it is quite doubtful if its presence would have ever been known if it had escaped detection before the launching. As a comparison the resistance of the bolt can be considered to be about the same as that of a ten-penny nail sticking up in the way of a modern locomotive when moving at the same speed as the *Connecticut* down the launching ways. It has been suggested that some of our worthy naval officers, who have so vociferously denounced the dastardly attempts, be granted the degree of E. H. (engineer of hysterics).

* * *

SHOP ARRANGEMENT AND COST OF OUTPUT.

We are wont to "pat ourselves on the back" in self-congratulation anent the wonderful improvements in shop construction and tools, and to "point with pride" to groups of new buildings of great extent, filled with the latest improved machinery and laid out in accordance with the ideas of some so-called expert who has figured all costs down to the sixteenth part of a cent. Unfortunately, however, the anticipated improvement is one of name and appearance only in some cases, especially that of a few railway repair shops which have been sadly disappointing in first results. Instead of showing any marked decrease of the cost of repairing a locomotive, the records may show that the cost is fully as much, or even more, under the new shop roof than under the old one that threatened to fall down at any moment. The work does not go off smoothly, and things are generally highly disagreeable for those in charge and responsible for results.

Railway corporations are notoriously reluctant to pay for competent supervision, and that means good foremen. New shops are often laid out on too broad a scale for the present conditions and the attempt is made to handle the work with the same force of foremen as before. The consequence is that the men are left largely to their own devices because it is physically impossible for the foremen to look after them. A man walking at an ordinary gait will cover a distance of about 300 feet per minute; if he has to exercise general supervision in a shop 600 feet long, a round trip means a journey of not less than 1,200 feet and a minimum time requirement of not less than four minutes. But competent shop supervision means a great deal more than merely walking back and forth. Of course the foregoing is an exaggeration because no competent general foreman chases himself about the shop continually; he depends largely upon the reports of his department foremen, but unless a shop is well-organized there will be a serious lack of coördination unless the general foreman gets out and hustles things along a bit. Again a foreman who has been used to a small shop finds himself utterly lost in some of our modern mammoth structures, and for the time being "loses his grip" on things. If railways must build big shops with the various buildings scattered over a quarter-section, they must expect that one of the offsets to the improved mechanical features will be an increased cost of supervision—but it is money well invested.

In this connection we may mention one bad feature of a new railway repair plant (which mechanically is admirable in every way and leaves little to be desired in the present state of the art) and that is the location of the lavatories. There are only two and they are located nearly 1,000 feet apart. The men consequently must lose considerable time going back and forth, and are exposed to the outer atmosphere while doing so. This is a serious drawback in cold weather as often severe sicknesses are traceable to colds contracted by leaving a warm shop in a state of perspiration. Each shop should have its own lavatory, centrally located, if possible.

* * *

A British patent has been granted for a ball-bearing lathe center which has for its object the reduction of the friction that is put upon tail centers by the weight of the work and the pressure of the cutting tool. The center proper is made with the usual V-point for the reception of the work; the body is reduced in diameter so as to slip within a sleeve in which it turns. The sleeve fits the tail spindle taper socket the same as in the ordinary construction. Races are provided in the center and sleeve for ball bearings of the end-thrust type. Frictional resistance to rotation of the tail center is thus reduced to so little that the center turns with the work instead of the work turning upon it, and thus wear is supposed to be practically done away with.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The *Caronia* is a vessel for the Cunard line recently launched at the shipbuilding yard of John Brown & Co., on the Clyde. Her length over all is 678 feet; breadth, 72 feet; depth, 52 feet; gross tonnage, 21,000 tons; draft, 32 feet; displacement at full draft, 29,800 tons; cargo capacity, 12,000 tons; speed, 18 knots. The *Caronia* will have accommodations for 2,650 passengers and will carry a crew of 450.

It is estimated that the New York Rapid Transit Subway will cost complete, $65,000,000; Pennsylvania R. R. tunnel, $50,000,000; New York and New Jersey R. R. tunnel, $15,000,000; Hudson and Manhattan R. R. tunnel, $10,000,000; New York and Queens tunnel, $10,000,000; and New York Central Terminal tunnel, $20,000,000. Total, $170,000,000 for increased rapid transit facilities in Greater New York.

The smallest electric motor in the world has been built by a watchmaker whose work has trained him to handle delicate machinery with the exquisite care required in making a motor that moves with all the regularity of a big machine, and yet is so small that its owner wears it as a scarf-pin. Viewed from a little distance the article has the appearance of a very valuable and rather curiously-designed pin. It is only when standing near to it that its nature can be discovered. The first thing to attract attention is the buzzing of the machine, which, by means of a current obtained from a small battery carried in the vest pocket, is kept in operation at a high rate of speed, with a noise like a bee buzzing. —*Street Railway Review.*

The association of German manufacturers of machine tools, in a report on the condition of the machine-tool industry, complains that sharp competition in foreign markets makes it difficult to obtain orders or remunerative prices, says the consul-general at Frankfort, Germany, under date of September 3, 1904. The importation of American and English machine tools into Germany is notably increasing. During the first half of this year, 1,100 metric tons of foreign machine tools entered Germany, against 450 tons in the same period of the preceding year. The association therefore demands higher tariff rates on imported machine tools, in order to check their importation and thus protect the interests of German manufacturers.

The importance of having light reciprocating parts in engines has been dwelt upon by all authors of works on machine design, but it is quite doubtful if their words have been taken seriously to heart, especially by the designers of locomotives. Many a designer would undoubtedly be greatly surprised if he could be shown the actual results of reducing the weight of reciprocating parts, even so little as 10 per cent. The *Engineer* cites an instance in which the piston of an automobile engine was made of aluminum in order to lighten it as much as possible, and the results are both surprising and gratifying. The speed of the engine was increased 300 revolutions per minute over the maximum that was possible when the heavier cast-iron piston was used.

The use of hot tar or pitch on European highways to prevent dust and to preserve the roadbed from deterioration by water is attracting much attention from those interested in good roads. It appears that ordinary dirt roads, when properly prepared and subjected to the application of hot pitch, can be made practically dustless, and in many respects as good as macadam or asphalt streets, at but a fraction of their cost. The pitch must be applied when the road surface is perfectly dry, and for that reason it must be done during the hot, dry summer months of July, August, and September. The pitch is heated to a temperature of from 140 to 170 degrees F., and thoroughly worked into the road surface, not merely plastered over it. It is poured into the center of the roadway and worked energetically over the surface and into it by means of stiff brooms. This leaves a rough untidy appearance, but a few hours traffic smooths it down, and after that wear is imperceptible for a long time.

We build bridges, skyscrapers, shops, railroads and other engineering structures in very quick time, but for some cause the construction of marine craft appears to be much slower in American shipyards than abroad. This is especially true of the construction of naval vessels; some of our battleships have been five or six years building. During this long period of construction the conditions of warfare, new inventions and improvements in ship construction combine to make a newly-finished battleship of practically obsolete type before she even sees actual service. A writer in *Cassier's Magazine* contends that a battleship could be built in twelve months if its construction was gone at in a business way with complete plans in full detail worked out before construction was started. He says that a large part of the time of building is consumed in making alterations and in finical details of finish which contribute nothing to the efficiency of the vessel as a fighter or as to her seaworthiness.

The committee appointed by the Association of Railway Superintendents of Bridges and Buildings to report at the fourteenth annual convention at Chicago, upon the comparative efficiency of steam hammers and drop hammers for pile drivers, decide in their majority report in favor of the steam hammer. They say that piles can be driven without injury to the pile into almost any kind of earth, and that it is guided home in much better fashion than can be accomplished by the drop-hammer. In Chicago, where perhaps more piles are driven for foundation work than anywhere else in the United States, steam hammers are used almost exclusively. Although the first cost with a steam hammer is much greater than with a drop hammer, its superior efficiency is considered to make the extra cost a good investment. The steam hammer does not require the piles to be banded, and without the bands the heads of the piles are left in better condition than is usually the case with the drop hammer.

The development of the high-powered automobile, capable of running at forty or fifty miles an hour, has brought a train of evil consequences to the users and the public, and it is a matter of grave concern to the automobile industry what the future will bring forth in the matter of repressive legislation if more moderation in speeding on public highways is not displayed by the drivers of these modern Juggernauts. As a matter of fact, however, it is a somewhat difficult matter to accurately judge of the speed of a car and the driver may often believe that he is traveling within the prescribed speed limits when he is considerably exceeding it. A useful device for automobilists who honestly desire to conform to speed regulations is the Warner auto-meter which indicates the rate of progression in direct readings from the slowest up to the highest attainable speeds within the power of the swiftest racers. This device works on the same principle as the cut-meter made by the same concern, and is said to be accurate within limits of one per cent.

A contemporary publishes a picture of a brick chimney 125 feet high which was built from a derrick. The derrick was erected to a somewhat greater height than the chimney, and was built to its full height before the chimney was started. The inside diameter of the chimney is 6½ feet, which makes the method of construction from a derrick somewhat puzzling, since the modern method of building chimneys of even smaller bore is to hoist all materials up through the chimney, using the walls of the chimney as a support for the hoisting apparatus and working platform. This method makes falsework unnecessary and considerably reduces the cost of construc-

tion. An analogous method is followed in modern practice in the erection of iron smokestacks. Instead of building a derrick alongside the stack, a short derrick is built around the base to support the stack, as it is being erected. The erection proceeds from the bottom, the succeeding sections being riveted to the bottom of the preceding section, which is held suspended in the air by tackle attached to the top of the derrick.

To even the most casual observer of events, the growing use of cement and concrete in railway and general construction work must be impressive. There are engineers who freely predict that concrete is the coming building material, and that it will supplant wood, brick and stone. When reinforced with iron or steel rods it is used for beams and has the great advantage of high resistance to heat. A sixteen-story office building has been erected in Cincinnati, and this is only one of many complete concrete structures that have been erected in this country and abroad within the past few years. Concrete construction is unique in that its strength increases with age; hence the designer of concrete structures need take no account of the deteriorating effects of age, but on the other hand may rest serene in the knowledge that his allowed factors of safety slowly increase as time passes on. An illustration of this condition occurred in Belgium two or three years ago when a fire occurred in a spinning mill built with concrete floors in 1898. The fire occurred in 1901 and tests made some time after the fire showed that the floors had gained from 130 to 200 pounds per square foot in safe carrying load.

An important change will be made in British patent practice beginning with January, 1905, when no patents will be granted for inventions save only those which stand the test for novelty after a search of the official records for fifty years back. In other words substantially the same practice will be followed as in the granting of German and United States patents. Heretofore in British patent practice, patents have been granted with practically no official search to determine the matter of novelty, so that as a matter of course many worthless patents were granted, but whether in a larger proportion than in American practice where the getting of claims allowed on an exceedingly slender basis has been reduced to a fine art, is doubtful. It is claimed that a large number of so-called "patent agents," "consulting engineers" and other touts have been exploiting the British patent office for their own ends. They have played on human vanity and credulity in getting worthless patents for parties who imagined that their social status was immensely improved by becoming patentees, or whose cupidity was played on by rosy prospects of immense returns for some foolish trifling thing of absolutely no novelty or value.

A consular report from Auckland states that an interesting change has recently been made in the signaling system in New Zealand's railway which it is thought will make collisions absolutely impossible. For a long time, up to a recent date, what is known as the "block" system has been generally used, but the "tablet" system has now been introduced. The essential point in the new system is that no engine driver is allowed to leave a station without a tablet in his possession, and the element of safety rests on the fact that the machines are so made that it is impossible for two of the tablets to be out at the same time. If a driver leaves Auckland for Newmarket with a tablet, that tablet has to be deposited in the machine at Newmarket before another tablet is issued allowing a return train to leave that station for Auckland, and the electrical connection between the two stations makes it impossible to extract a tablet from the Auckland machine until the tablet has been put into the machine at Newmarket. It is claimed by railroad experts that under the new system two trains cannot be on the same section at once, so that the danger of collisions is entirely done away with.

LONGEST PIPE LINE.

The use of the pipe line for the transmission of petroleum over long distances was undoubtedly one of the greatest advances in the handling of a certain class of freight since the invention of the locomotive; the cost of pumping oil is much less than shipping in barrels or tank cars and the danger of fire is minimized. The pumping stations at intervals are the only visible evidences of such a route, and the pipe line itself follows a "bee line" over hill and down dale with absolutely no deviation from a straight line to ease the grades. It lasts indefinitely because of the preservative effect of the oil, and calls for practically no attention save the periodical patrol of the pipe-line walker who covers as much of its length daily as he is able to walk at a stiff gait. Occasionally a leak will spring forth, but it is usually known in the pump stations before it is discovered by the patrol, if of serious proportions. All the pump stations are connected by telegraph or telephone lines, and the amount pumped from each station is transmitted to the next station by wire. This report must tally with the number of barrels received; if it does not it is known that a leak has developed or that an error has been made in the report. The longest pipe line in the United States will be that from Red Fork, Indian Territory, to Bayonne, N. J., a distance of 1,800 miles. The pipe line itself contains thousands of barrels; it requires something like 20,000 barrels to fill the line from Red Fork to Kansas City alone.

TRIPLE VAPOR ENGINE.

The binary-vapor engine using sulphurous acid gas and steam, which was designed and built for Prof. Josse, of the Royal Technical High School, Charlottenburg, Germany, has attracted much attention—more perhaps on account of its theoretical interest than its practical possibilities. Yet when it is considered that this system increases the power production fifty per cent. for the same steam consumption, it must be admitted that there is a powerful advantage in favor of the use of two or more substances having different vaporization temperatures. Another German, Mr. K. Schreber, has shown that with a triple-vapor engine it is possible theoretically to secure a heat efficiency of nearly 38 per cent. He proposes the use of ethylamin, water and aniline. Ethylamin can be advantageously worked between the temperatures of 85 and 180 degrees F.; water in the form of steam between 180 and 360 degrees F.; and aniline between 360 and 600 degrees F. In Mr. Schreber's imaginary engine aniline is heated in a boiler and after passing through the engine, it is cooled in a condenser, the liberated heat being utilized to evaporate water which has already been heated by passing it through an economizer. In the second stage the steam passes through a second engine into a condenser where its heat evaporates ethylamin, also previously heated by the waste gases of the boiler passing through an economizer. The ethylamin works a third engine and is condensed for re-use. If the limits are placed at 70 and 600 degrees F. instead of 85 and 600 degrees, the author of the paper figures that the heat efficiency would be 44.5 per cent.

ALLEGED DISCOVERY OF THE PROCESS FOR MAKING HARD RUBBER.

There was once a machinist named George, who worked at the bench and was always more interested in hearing the quitting time whistle blow than in any other event of the day. One day the first yell of the whistle found him with his hammer in the air, and being alarmed lest it should make even part of a stroke beyond working hours, he permitted the hammer to fall and it broke a bottle containing a certain chemical which happened to be on his bench and the fluid ran over a sheet of rubber that also was on the bench. To wipe up the mass after the whistle had blown was not the way George did business, so he went home. In the morning when he examined the rubber that had soaked all night in the fluid, he found that it was as hard as a piece of board. Here now came in the worldly wisdom of this machinist. Instead of cleaning up his vise bench, and throwing the spoilt rubber and broken chemical bottle into the rubbish box without thinking anything more about the mishap, George reflected that the change in the consistency of the rubber was due to the chemical that had been anointing it all night. Then the question occurred, Would hard rubber have any value as an industrial product? The secret of how to make hard rubber was carefully guarded, a com-

pany was formed to put articles made from it upon the market and the discoverer is now a multi-millionaire.—*Locomotive Engineering.*

RECUPERATIVE POWER OF PEAT.

Page's Magazine, September, 1904.

A good deal has been heard recently about the utilization of peat on a large scale, and it may be interesting to point out that peat differs from coal in that after removal a fresh lot *grows up* again. The rate varies in different parts of the world, but the following are some well authenticated cases:

Lake of Constance—A layer of 3 feet to 4 feet thick in 24 years.

Near Hanover—A layer of 4 feet to 9 feet thick in 30 years.

Valley of Somme—A layer 3 feet thick in 30 to 40 years.

Of course, a great deal depends on the peat-forming value of the mosses, and on various geological and geographical features of the country. Some mosses may only give a foot thickness of peat in 30 years, but taking peat bogs the world over 10 feet in 100 years seems to be a fair average.

Taking these figures and assuming absolutely safe data for working out the horse power, we arrive at rather interesting figures.

Assuming that one cubic foot of cut peat will give 10 pounds of solid fuel, and that 5 pounds of peat fuel are equivalent to one brake horse-power hour, then it can be shown that 640 acres or one square mile of peat bog 10 feet thick, will give:

$$\frac{640 \times 43560 \times 10 \times 10 \text{ lb.}}{5 \text{ lb.}} = 550{,}000{,}000 \text{ B. H. P. hours.}$$

If we assume that the square mile of peat bog grows at the rate of 10 feet in 100 years, then we may say that such a peat bog is good for—

$$\frac{550{,}000{,}000}{365 \times 24 \times 100} = 630 \text{ B. H. P.}$$

for all time. As a matter of fact the working day may very well be taken at 10 hours, so that 1,500 B. H. P. may be calculated as the output of a square mile of peat bog, so worked that it is never permanently diminished.

RELATIVE COST OF CUTTING BY EMERY WHEELS AND BY FILING.

Extract from Paper presented by Mr. T. Dunkin Paret, at the May 12, 1904, Meeting of the Franklin Institute.

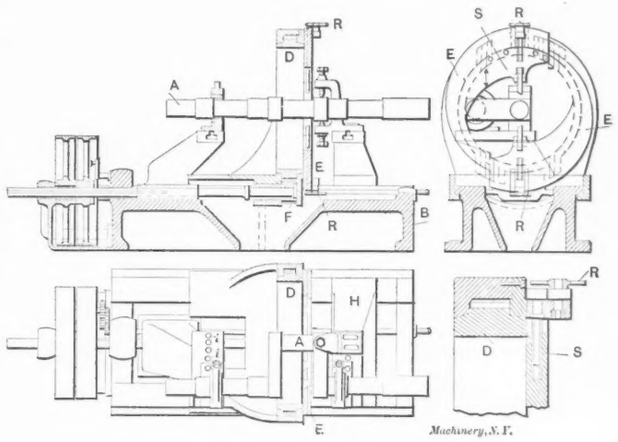
An attempt has been made to arrive at the cost of grinding both on cast and wrought iron, and also at the cost of filing, but it must be remembered that the conclusions which are drawn from very unequal series are not altogether sound. In arriving at these costs, a wheel 10 x 1 is assumed to weigh 7¾ pounds and to cost $1.65—that is, 75 per cent. discount on a list price of $6.60. Labor is calculated at the rate of $1.75 for a day of ten hours. No allowance is made for power. Under these conditions, and counting only the cost of wheel material and the actual time of grinding, at a pressure of 112 pounds, it costs 5 26-100 cents to grind 1 pound of cast iron and 27 53-100 cents for the same quantity of wrought. This cost, so far as it refers to cast iron, is derived from the 244 minutes test of thirty-six wheels. It is interesting to note that the few trials of specially fast cutters show a diminished cost. This diminished cost (on cast iron) is almost the same at 80 and 110 pounds. At 110 pounds the cost of material is greater than at 80 pounds, while the cost of labor is less. At 80 pounds the total cost is 3 40-100 cents per pound; at 110 it is 3 52-100.

A few tests were made with the file on bars furnished for the grinding test, three different machinists being timed. These gave a cost per pound of 29 90-100 cents for cast iron and 74 75-100 cents for wrought. The minute removal by the file for cast iron was 15-100 of 1 ounce; for wrought iron 6-100.

LATHE FOR TURNING CRANKS.

Zeitschrift fur Werkzengmaschinen und Werkzenge, April 5, 1904, p. 271.

A lathe attachment made by Emil Capitaine & Co., Frankfort-on-Main for turning cranks and other similar articles is shown herewith. The tools are attached to a rotating ring, that revolves about the center of the part to be turned. In the illustration the device is shown to be formed of two independent parts, that may be separated from each other for the introduction of the work. These two parts *E* and *E'*, when fastened together serve as a support for the rotating ring *D*. The transverse feed is obtained by means of a star wheel *R*,



Crankshaft Lathe.

working through a light spindle *S*. Each section of the ring carries a cutter, so that the work can be executed with two tools at once, thus giving the advantage of having cuts taken on opposite sides which tends to avoid chattering. The crank *A*, to be turned, is fastened to the bolsters *H H*, which are given a longitudinal feed motion by a mechanism not shown.

G. L. F.

KRYPTOL, A NEW SUBSTANCE FOR ELECTRIC HEATING.

Abstract of Consular Report No. 2084 by Frank H. Mason, Berlin.

Among the notable recent German inventions in the field of applied science is an electric resistance material for heating purposes, to which has been given the name "kryptol." The exact method of its preparation and the proportions of its ingredients employed are not disclosed by the specifications of its patent, but it is a mixture of graphite, carborundum, and clay so combined as to form a loose granular mass or powder of four grades or degrees of coarseness, which are severally best adapted to different heating operations.

Electric heat may be developed by two general methods: The electric circuit may be broken, so that a voltaic arc is formed, and the charge in the furnace is thus heated directly, or the current may be transmitted through a conductor that offers enough resistance to generate heat, which is imparted to other substances by contact. This is the indirect electrical heating system, of which kryptol offers the latest and most interesting example.

The two main difficulties inherent in voltaic-arc furnaces are (1) Only very high temperatures are developed, which are difficult to modify or control, and (2) the arc consists largely of incandescent particles of (usually carbon) electrodes, which render the flame so impure as to preclude its use for many important purposes. Both of these defects are remedied by kryptol, which develops heat of any desired intensity from a gentle warmth up to 5,400 degrees F., and is clean and free from dust and other impurities. Moreover, it avoids the use of platinum, nickel, and other metallic wires and foils that have been hitherto used in resistance furnaces, thereby securing important economy and avoiding the danger of short circuiting and other accidents, which is always more or less present when metallic spirals in connection with crucibles are used.

The property of kryptol, upon which its efficiency depends, is the fact that it offers to an electric current the requisite degree of resistance to generate a high degree of heat without destruction to its own substance. The apparatus consists simply of a chamotte or earthenware plate inclosed at its edges in a wooden frame and bounded at two opposite sides

by carbon electrodes which rest upon the plate and are connected by insulated wire conductors with a current supply, forming an electric current when the break between the electrodes is closed. Upon the chamotte plate, which is usually about two feet square, but may be of any convenient size, is loosely strewn the granulated kryptol to a depth of about an inch. When the kryptol is laid continuously across the plate it forms the electrical connection between the two electrodes and closes the circuit. When, however, the kryptol is brushed or scraped aside so that an open, uncovered space is formed through the layer across the plate, the circuit is broken and the apparatus remains, so to speak, dead. If now the kryptol is brushed into the open space, so as to form a connection between the two masses lying against the electrodes on either side, the circuit is at once restored, and the kryptol forming this thin connecting layer begins to sparkle and glow, becoming in a few moments incandescent and generating a heat that will raise cold water to boiling in three or four minutes.

A peculiarity is that the incandescent action takes place only at the places where the layer of kryptol on the plate is thinnest, and it is therefore easily possible to create heat just in the place where it is wanted and not elsewhere, for in this case the thick bed of granular material on other portions of the plate remains cool and impassive and may be touched or stirred by the naked hand with entire impunity. The finer the grains of kryptol the less active is the incandescence, and it is for this reason that the four different grades or numbers of the material are made, to be used as may be required in generating different temperatures.

This extreme tractability, by which the temperature can be absolutely regulated by increasing or diminishing the strength of the current or by altering the thickness of the kryptol layer, one or both, renders it applicable to a large variety of practical uses; it lends itself with great convenience to all the finer smelting operations in scientific and industrial metallurgy. These operations may be carried on by means of a small crucible furnace, which consists of an iron shell with an enamel lining filled with coarse-grained kryptol, in the center of which is hung a movable graphite crucible, in which any temperature up to 3,600 degrees F. may be generated. With a current of 15 amperes, nickel, the smelting point of which is about 2,900 degrees F., may be fused in about six minutes.

Some of the steel and cutlery manufacturers in Westphalia are experimenting with kryptol with a view to its employment for tempering, annealing, and case-hardening steel and iron bars, knives, scissors, and other implements. Such processes would become thereby automatic and independent of the skill of the workman. As the ingredients of kryptol will withstand any temperature up to 5,400 degrees F., its use for heating up to that limit is restricted only by the nature of the material of which the furnace and crucible are composed. Being itself a poor conductor of heat, it retains its warmth for a long time.

For chemical laboratories the new material has already been adopted by the University of Berlin, the Technical College at Aix la Chapelle, the Imperial health office at Berlin, and other State institutions. When used in ovens and heating devices of various patterns it enables the chemist to heat substances to any desired temperature and to maintain an unvarying degree of heat for an indefinite period. In elementary organic analysis it is frequently necessary to heat parts of the substance under examination to different temperatures and to leave another portion not heated at all. For this purpose a simple but effective apparatus has been devised. It consists of an iron frame on which is laid a firebrick trough or gutter, glazed inside and filled with kryptol. In this is laid the combustion pipe, which may be a glass tube, containing the material to be treated. The current being sent through the whole, even mass of kryptol, heats the tube uniformly throughout its length; but when it is desired to heat one portion to a high temperature, it is only necessary to scrape the kryptol aside and reduce the thickness of the layer under that part of the tube, when it at once begins to glow with accelerated heat, while the temperature of the other parts remains unchanged. If it is desired to withdraw or exclude the heat entirely from the central part of the tube, two copper forks, which slide along a brass conductor, are introduced into the kryptol, which take up the current and pass it by the conductor over the intervening space, leaving the kryptol and that section of the tube cold and excluded from the heating operation.

A NEW PROCESS FOR THE PROTECTION OF IRON AND STEEL FROM CORROSION.

Abstract of Article by Sherard Cowper-Cowles in the Electro-Chemist and Metallurgist, June, 1904.

Zinc has proved the most effective coating for iron and steel, and hot galvanizing, with all its attendant disadvantages, is the process most extensively used for applying the zinc coating. Electro-zincing or cold galvanizing is used for special classes of work, and is extensively employed by the Admiralty for giving boiler tubes a thin flashing of zinc for the purpose of detecting flaws and protecting the tubes from corrosion during the time of assembling and erection. Works have just been completed for a new process to which the name of "Sherardizing" has been given. One point of particular interest about the new process is that iron and steel can be coated with an even deposit of zinc at a temperature of several hundreds of degrees below the melting-point of zinc.

The first step in the process is to free the iron from scale and oxide by any of the well-known methods, such as dipping in an acid solution or sand-blasting. The articles to be rendered rustless are then placed in a closed iron receptacle, charged with zinc dust, which is heated to a temperature of from 500 degrees to 600 degrees F. for a few hours and allowed to cool; the drum is then opened and the iron articles removed, when they are found to be coated with a fine homogeneous covering of zinc, the thickness depending on the temperature and the length of time. It will be observed that the temperature required to bring about this result is about 200 degrees below the melting-point of zinc. The low temperature required makes the process cheap as compared to the process of dipping in molten zinc, and has the additional advantage that it does not deteriorate iron or steel of small section to the same extent as hot galvanizing. The whole of the zinc dust is consumed; there is no waste of zinc as in the hot galvanizing process. This new process of galvanizing is not limited to the coating of iron with zinc, it has been successfully applied to coating iron with copper aluminum and antimony. It has also been applied to various other metals, for instance, aluminum and copper with zinc. Copper and its alloys subjected to this process are casehardened on the surface, and can be rendered so hard as to turn the edge of a steel tool.

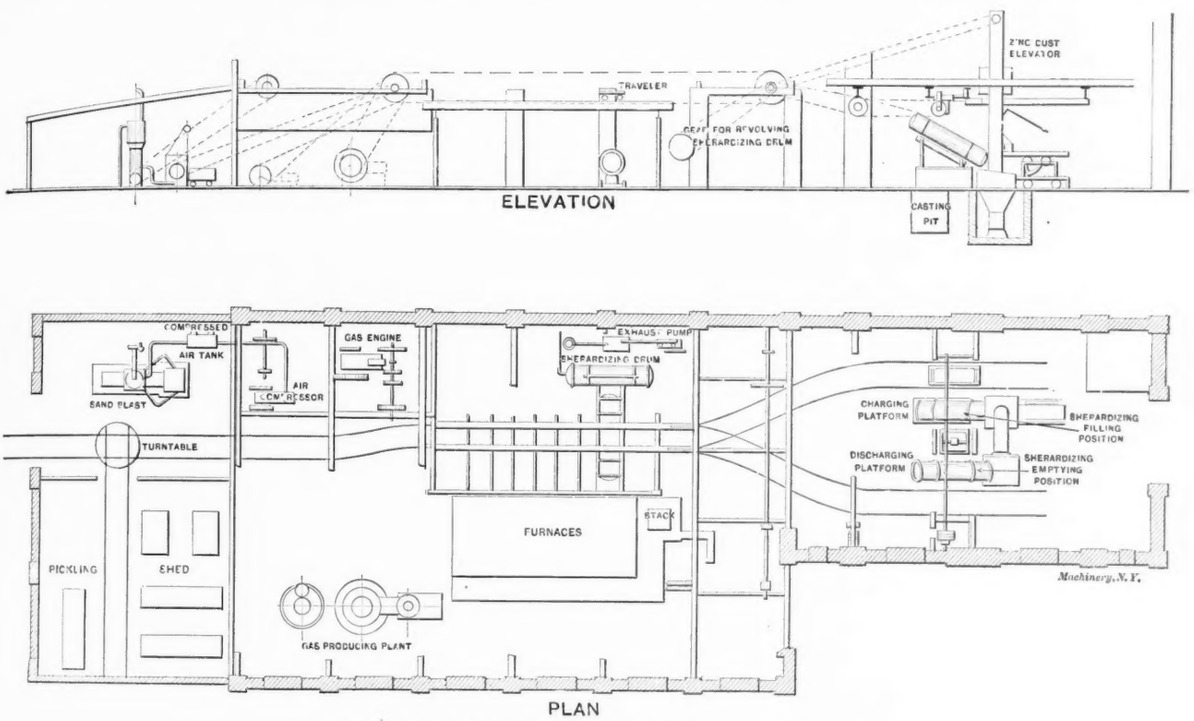
The zinc powder used in the process is the zinc dust of commerce, and must not be confused with zinc oxide; it is obtained during the process of distilling zinc from its ores. Zinc dust at the present time is used for a variety of purposes, and can be obtained in any desired quantity. The average price of zinc dust for the year 1903 was $95 per ton, (Great Britain) which is slightly below the average price of virgin spelter. The analysis of two samples of zinc dust such as are employed for Sherardizing gave respectively 85 and 85.06 per cent. and 81.86 per cent. metallic zinc. Both samples, when examined under the microscope, seemed to contain small bright metallic beads, unevenly distributed through the dust, and it is probable that this may account for the different percentage given by analysis. One of the peculiar properties of zinc dust is that it cannot be smelted or reduced to the metallic form under ordinary conditions, even when heated to a very high temperature under considerable pressure. This property is very advantageous for the new process of dry galvanizing, as it does away with the risk there might otherwise be of melting the finely-divided zinc by overheating the furnace. The receptacle in which the zinc dust is placed and heated is preferably air-tight and the air exhausted so as to prevent the formation of too much zinc oxide; or, if this is not feasible, it is advisable to add about three per cent. of carbon in a very fine state of division. If the percentage of oxide is allowed to increase beyond certain limits it is found that the deposits become dull in appearance instead of having

a bright metallic luster, although good deposits of zinc can be obtained from zinc dust varying considerably in composition. To prevent the iron receptacle in which the process of Sherardizing is carried on from becoming coated with zinc, it is found advantageous to coat the inside of the drum with plumbago or black lead. Articles coated with grease receive as good, if not a better coating of zinc than those which are free from grease. This fact is of considerable importance, as it enables machined work, such as bolts, nuts, screws, etc., to be thrown direct after machining into the Sherardizing drum without any preparation or cleaning. The articles when they have been heated in the zinc dust for the period necessary to obtain the thickness of zinc required, can be removed, while the zinc dust is still hot; although the better practice is to allow the zinc dust to cool to a temperature at which the articles can be readily handled, as the deposit of zinc is whiter and less oxide of zinc is formed. The new process of dry galvanizing offers many facilities and great economy to those manufacturers who have not sufficient work to keep a large bath of molten zinc continuously at work. Articles can be Sherardized at a few hour's notice, starting all cold, as the drums can readily be heated by gas or coke furnaces, the whole operation occupying only a few hours. When the plant is not at work, there is no waste as in the case of hot galvanizing, when the zinc has to be kept in a molten condition day and night.

A useful type of furnace for small work consists of a closed iron chamber in the form of a cylinder or polygon, and arranged to be rotated or oscillated about its axis. The chamber is provided with an iron door either at one end or at the side, depending upon the class of articles to be treated; a side door is found to be the most suitable for small articles such as bolts, nuts, small castings, etc., and the end doors for tubes, oblong or cylindrical articles. In the latter case the cylinder is oscillated and rotated on its axis; in the former case it is rotated and provided with baffle plates to insure the articles under treatment being turned over and thus becoming uniformly coated by bringing all parts into intimate contact with the zinc dust.

Figs. 1 and 2 show the general arrangement of a Sherardizing plant which has recently been completed, comprising four furnaces capable of taking drums 2 feet by 8 feet. These drums will hold about two tons of material, the weight depending on how closely the articles pack. The furnaces are heated by Dowson producer gas, which is led by iron pipes to the back of the furnaces. The discharging or charging of the drum is effected by running the truck on which the drum is placed onto a table, the latter being tilted by gearing so that the drum can be discharged or charged with zinc dust from a chute above. After being charged with zinc dust and the materials to be galvanized the drum is brought to a horizontal position, the cover closed and the air exhausted, when it is ready to be charged into the furnace.

The comparison of the surfaces obtained by hot and cold galvanizing and Sherardizing is different in each case, but they can readily be distinguished by anybody conversant with the three processes. In the case of hot galvanizing, the surface is spangled, or has the appearance of cast-metal. In the case of cold galvanizing, the surface is free from spangles and has a matte or frosted surface, uniform if the work has been well executed. Sherardizing is again distinctive from the two former processes; the general appearance resembles more that of cold galvanizing than hot galvanizing, but is more lustrous and metallic, and is uniformly distributed over the whole surface, which is not the case with the hot and cold galvanizing processes. The Sherardizing process, although similar to cold galvanizing in some respects, is also similar to hot galvanizing in other respects, inasmuch as the zinc



Figs. 1 and 2. Plan and Elevation of Sherardizing Plant

alloys with the iron and forms a protective zinc-iron alloy intermediate between the zinc coating and the underlying metal.

As Sherardizing is effected at a very much lower temperature than hot galvanizing, the temper of steel wire is not reduced as it is in the latter process. A number of steel and iron bolts treated at varying temperatures when tested for tensile strength were found to be equal in strength to bolts which had not been treated. In practice, Sherardized iron and steel are found to withstand to a remarkable degree the ordinary corrosive agents to which galvanized iron is exposed; even after the apparent removal of all the zinc by filing or abrasion the iron is still non-corrosive. This valuable property is doubtless due to the protective action of the zinc-iron alloy formed on the boundary line between the iron and zinc. The dry process of galvanizing is cheaper than hot galvanizing for the following reasons:

1. Less zinc is required to give the same protective coating, as the zinc is evenly distributed. 2. The temperature required is low. 3. The labor is less, as the articles do not require to be cleaned as carefully as in hot galvanizing. 4. No flux is required, no dross or skimmings are formed. 5. There is no danger of explosion or breaking of castings and distort-

ing of thin iron work. 6. Sherardizing machine work does not require refitting, as the coating is evenly distributed. 7. There is no reduction in tensile strength as in the case of hot galvanizing. 8. The coating is more uniform and even than that obtained by hot or cold galvanizing. 9. The work can be placed direct in the Sherardizing drum from the pickling vat without drying. 10. The process can be worked intermittently without waste. 11. Iron can be coated with zinc to any desired thickness.

TRADES AND FACES.

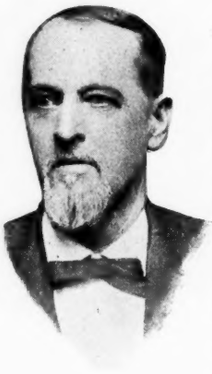
English Mechanic and World of Science, August 19, 1904, p. 26.

It is an undisputed fact that a man's trade or profession affects, to a more or less noticeable extent, not only his disposition, but even his physiognomy. That certain faces appertain to certain callings is a matter of everyday observation. The expression of the "horsey" man—be he trainer, jockey, or groom—is quite unmistakable and peculiar. The professional cast of features of the doctor or the lawyer is equally well known, and yet more strikingly distinctive is the face of the actor. Butchers and shoemakers, tailors, publicans, and men-servants all have facial peculiarities which they hold in common with all other members of their trade, and to a keen observer of expression all workers of whatever station bear upon their features the impress of their labor. One specially instructive instance, among many others, has been related by a well-known medical man. In his work as surgeon in the hospital of a shipbuilding town, he was struck with the lowering brows and forbidding expressions of the riveters and boiler-smiths with whom he came in contact. Only by experience did he come to understand that the apparent watchful hostility which each seemed to exhibit was in reality a trick of the countenance merely, and not at all indicative of the actual feelings. And pondering over this he arrived finally at the conclusion that the scowling look, which he maintains is common to all kinds of smiths, is due to the constant automatic contraction of the brow to protect the eyes from the flying sparks, as the heavy sledge descends on the glowing metal. A blacksmith is, as a rule, credited with being a serious and downright man, who "looks the whole world in the face" and stands no nonsense. It has been suggested that the mere act of striking heavy blows, accompanied as it always is with a flush and a frown, has about it so much suggestion of wrath and determination as in time to affect the character to a certain extent. In the case of the shipbuilders also their work is so noisy as to render them all slightly deaf, which infirmity always gives a closely watchful expression to the features. Another curious, and some may think far-fetched, explanation of a "trade expression" has been given in the case of the tailor. Let anyone watch the face of a person engaged in cutting a thick piece of material with a pair of scissors, and it will be seen that the lower part of the face works in involuntary unison with the blades. May not (so it is argued) the constant working of a tailor's jaws concomitantly with his shears help largely toward bringing about that cast of countenance which distinguishes him?

The well-known and recognized type of face belonging to the horsey man has its peculiarity chiefly in the set of the mouth and chin. This is explained from the fact that the muscles which close the jaws and compress the lips are always called into play when we are asserting our will over that of a horse. The incessant manifestations of his own power and will over that of an animal tends to give that firmness of jaw and thinness of lip which a horseman wears. It is somewhat different when the command is exercised over men instead of animals. The firm mouth is still seen in the drill-sergeant; but the commanding eye—which is absent in the groom—is also added, because in dealing with men the higher method of expressing authority is made use of. Generally speaking, it is strenuous contest with ever-recurring minor difficulties which produces thin and compressed lips. Many housewives who suffer the little worries of life to prey upon them, or whose existences are a perpetual struggle to make both ends meet, exhibit this peculiarity, even to extremes. Compressed lips are generally rather a sign of weakness than strength. A strong will is above the perpetual petty strife they indicate. The commanding officer, sure of his men's obedience, lacks the look of tension which his sergeants wear, and that absolute monarch the sea-captain, though his face carries authority and power, has the easily-set mouth of confident assurance. It has been remarked that there is a certain marked resemblance between the types of face, especially the calm lips, belonging to the naval officer and the engine-driver, brought about by the fact that both are absolute masters of the powers they control.

* * *

OBITUARY.



J. Ramp.

Mr. J. B. Ramp, one of the men who witnessed the most important years in the mechanical development of this country, died on September 11th, at Burlington, Iowa. During his long career he was continuously engaged in the foundry business. He was born in 1830, in New York City, and began to learn the foundry trade in his thirteenth year, taking the position of foreman when he was 21 in the shop where he served his apprenticeship, at Trenton, N. J.

Mr. Ramp served four years as a volunteer in the Federal Army and returned at the close of the war to accept a position with the Turner & Vaughn Iron Works of Cuyahoga Falls, Ohio, where he was superintendent of the foundry until the time of the erection of the large Mississippi River locks at Keokuk, Iowa. The foundry business at this point needed a man who could successfully produce the large and complicated casting necessary for the construction of these locks and it was this interest that induced him to come West.

In 1882 Mr. Ramp accepted a situation with the Murray Iron Works Co., of Burlington, Iowa., where he spent the rest of his career as superintendent of the foundry department. During his twenty-two years' service there the foundry has grown to three times its original size and capacity, and is to-day said to be the best equipped foundry in the West. During Mr. Ramp's direction there has never been a strike, and not until late years was there any regular organized union. He endeavored to bring the workmen to see that their foreman was their best friend, while able management and energetic, resourceful efforts on his part made his work profitable to the company. Molders who entered the shop for the first time were usually impressed with its orderly appearance and systematic arrangement, and many who served their apprenticeship under Mr. Ramp command first-class positions to-day. Among these are Mr. Ramp's two oldest sons, Herbert M. Ramp, superintendent of the General Electric Company's foundry and iron department, Schenectady, N. Y., and Paul R. Ramp, superintendent of the foundry department of the Wheeler Condenser and Engineering Works, Carteret, N. J.

Seven or eight years ago Mr. Ramp devised a molding machine to do the heavy ramming involved in making heavy castings. The machine has since proved its efficiency and durability and is in operation to-day. Cars are arranged to carry the heavy flasks under an air cylinder press, where the mold is rammed evenly in an instant and then drawn away. The past year the machine was enlarged and improved so that four operators can be at work at the same machine and two whole molds can be made at the same time.

* * *

To get a nicely mottled effect on casehardened work a toolmaker recommends that instead of dipping it all under at once in the hardening bath, the dipping be done jerkily; the result is a series of mottled bars across the work, each of which denotes its position at the surface of the bath as it was momentarily arrested in the plunge.

* * *

The bridge over the Zambesi River at Victoria Falls on the Cape-to-Cairo railroad in Africa is 420 feet above the low water level.

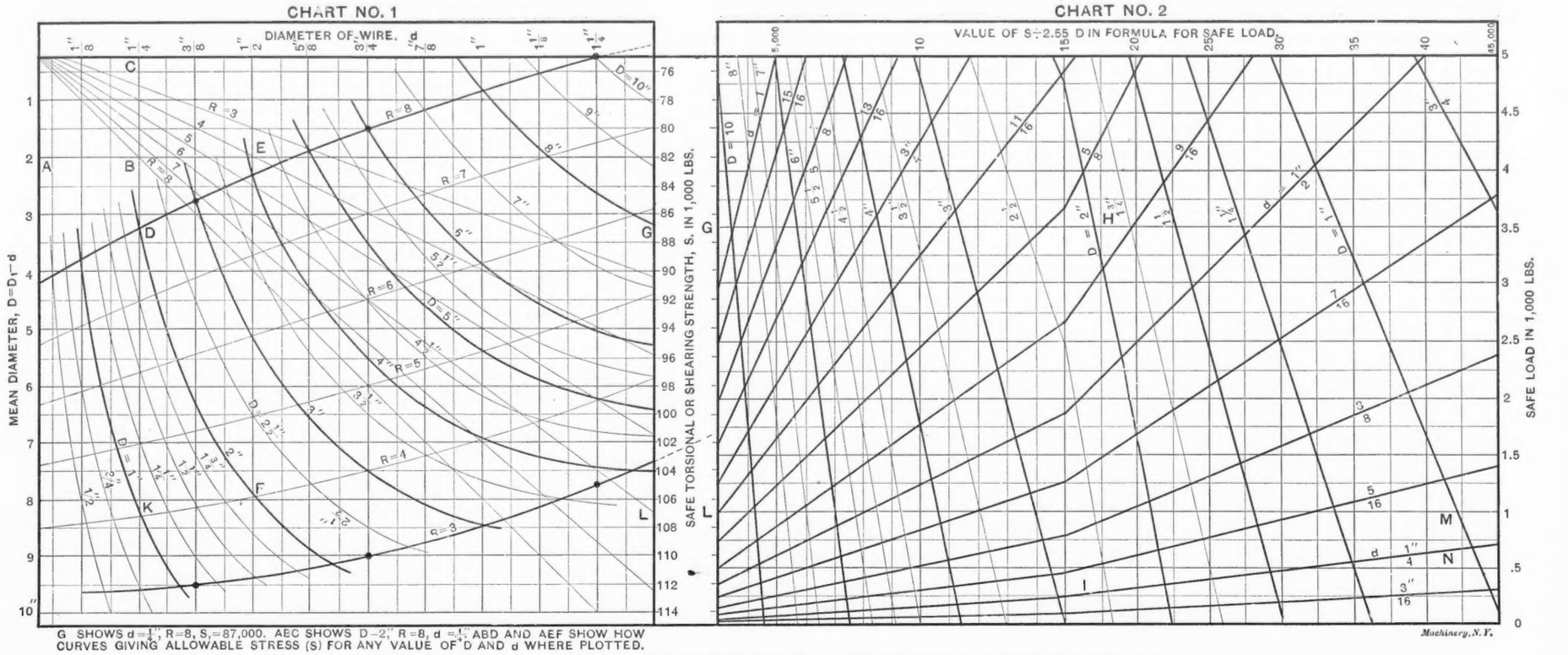


CHART NO. 1
DIAMETER OF WIRE, d
MEAN DIAMETER, D=D₁−d
SAFE TORSIONAL OR SHEARING STRENGTH, S, IN 1,000 LBS.
CHART NO. 2
VALUE OF S÷2.55 D IN FORMULA FOR SAFE LOAD.
SAFE LOAD IN 1,000 LBS.
Machinery, N.Y.

G SHOWS d=1/4", R=8, S=87,000. AEC SHOWS D=2", R=8, d=1/4". ABD AND AEF SHOW HOW CURVES GIVING ALLOWABLE STRESS (S) FOR ANY VALUE OF D AND d WHERE PLOTTED.

These two Diagrams show the Method of Constructing Chart No. 3. They are Drawn to the same Scale as the latter.

CHARTS IN DESIGNING.—3.

HELICAL SPRINGS.

JOHN S. MYERS.

Desired: A chart for helical springs of round steel giving the safe load and deflection of same. This series of charts is intended to illustrate the development of curved line charts from straight line ones.

The formula for safe load is $P = \frac{8d^3}{2.55\,D}$, where P = safe working load in lbs., S = safe torsional or shearing strength of bars, and D = mean diameter of coil = outside diameter D_1 —diameter of bar d.

From "Machine Design," by Prof. C. H. Benjamin, the safe value of S as deduced by experiment,* varies with the ratio of mean diameter of coil to diameter of bar, and also with the size of bar used. Safe values are given in the following table, where R = the above ratio.

For bars below ⅜-inch diameter,

$R = 3$. $S = 112{,}000$.

$R = 8$. $S = 85{,}000$.

For bars 7-16 inch to ¾ inch diameter,

$R = 3$. $S = 110{,}000$.

$R = 8$. $S = 80{,}000$.

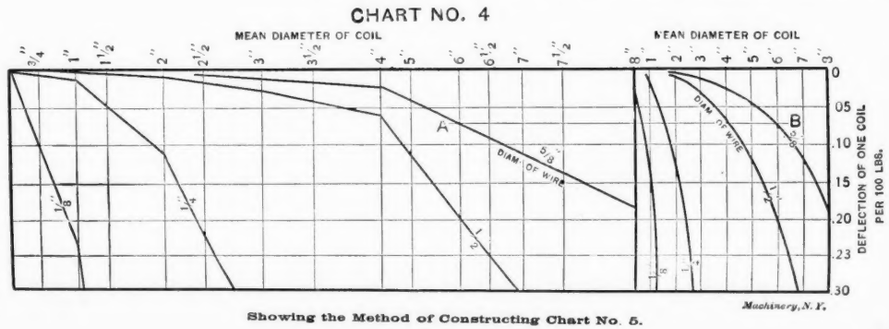
For bars 13-16-inch to 1¼-inch diameter,

$R = 3$. $S = 105{,}000$.

$R = 8$. $S = 75{,}000$.

In chart No. 1 the diameter of wire was first laid out on a uniform scale at the top of the chart and values of S ranging from 75,000 to 114,000 on the side of the chart. The stress as given in the table above was then spotted off for $R = 3$ and $R = 8$, on the line corresponding to diameter of bar, and a curve $R = 8$ and $R = 3$ drawn through the points.

The intervening space was then divided into 5 equal parts



Showing the Method of Constructing Chart No. 5.

* These experiments were conducted by Mr. Roy A. French and were part of his thesis for a master's degree.

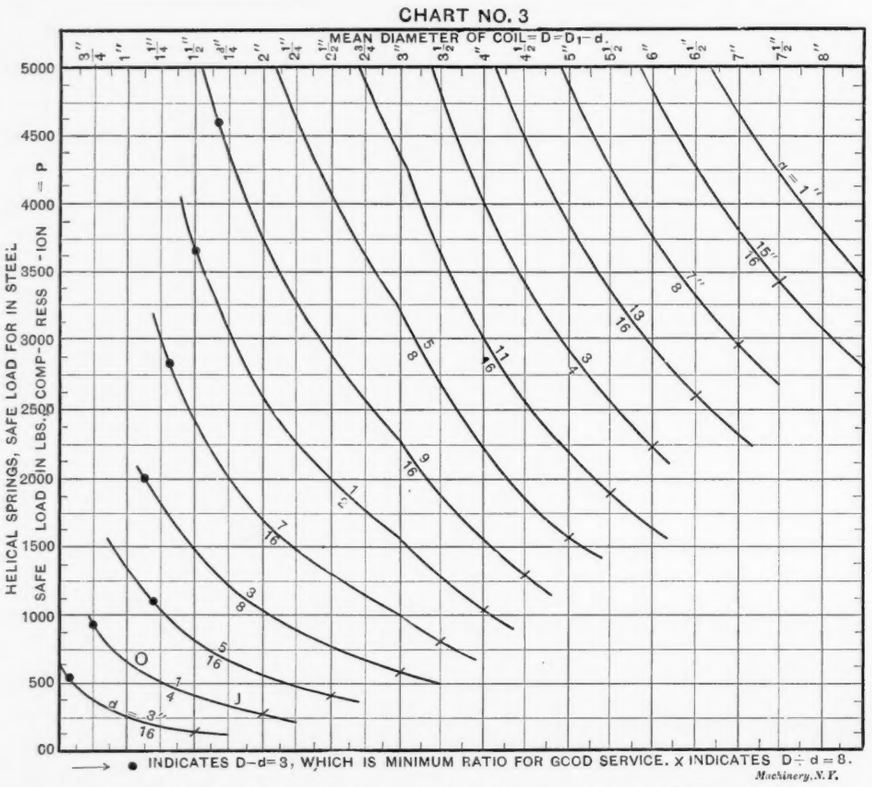


CHART NO. 3
MEAN DIAMETER OF COIL = D = D1 − d.
HELICAL SPRINGS, SAFE LOAD FOR IN STEEL.
SAFE LOAD IN LBS. COMPRESSION = P
● INDICATES D−d=3, WHICH IS MINIMUM RATIO FOR GOOD SERVICE. x INDICATES D÷d=8.
Machinery, N.Y.

Diagram showing Safe Load for Coil Springs of different Diameters, from Wire of different Diameters.

Notation for Chart No. 3.

D = mean diameter of coil = $D_1 - d$.

d = diameter of wire.

S = safe torsional or shearing strength.

P = safe load.

$$P = \frac{S\,d^3}{2.55\,D}$$

For extension springs $P = 2/3$ of above value. Where springs are subjected to shock use about $2/3\ P$. The foregoing is for round bars. For square bars safe load = $1.2 \times P$ for round bars.

Let $R = D \div d$; then,

For Bars Below	R =	S =
3/8" diam.	3	112,000
	8	85,000
3/4" diam.	3	110,000
	8	80,000
1 1/4" diam.	3	105,000
	8	75,000

(From Summary of Tests by Prof. C. H. Benjamin, at Case School of Applied Science. Relations of D, d, R and S are shown in Chart No. 1 on the previous page.)

ERRATA: Chart No. 1, for "G shows, etc." read "C D G shows." Chart No. 3, for "Indicates D−d=3," read "Indicates D÷d=3."

and the curves $R = 4$, 5, 6 and 7 drawn through. These lines now give values of S for any value of d and R. Thus $C\,D\,G$ shows diameter of wire $d = 1/4$-inch; ratio $R = 8$; safe stress $S = 87{,}000$. Next the side scale was numbered to represent mean diameter $D = D_1 - d$, and lines drawn to perform an operation of division $\frac{D}{d} = R$, for values of $R = 3$, 4, 5, 6, 7 and 8. Thus $A\,B\,C$ shows $D = 2$ inches; $R = 8$; $d = 1/4$-inch. The curves representing D were then drawn by projecting, thus $A\,B\,D$ and $A\,E\,F$ being two points on the curve $D = 2$ inches. These curves now give the value of S for any value of d and D.

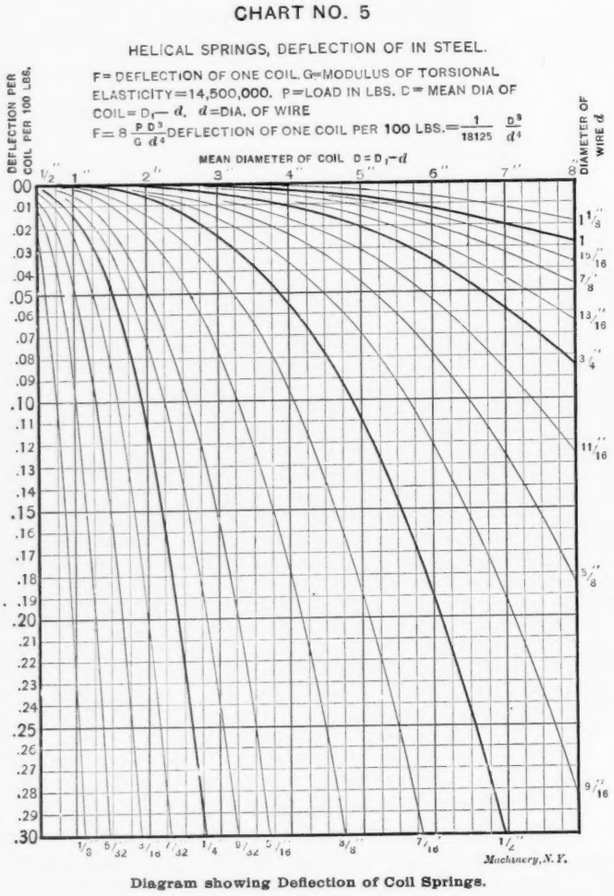


CHART NO. 5
HELICAL SPRINGS, DEFLECTION OF IN STEEL.
F = DEFLECTION OF ONE COIL. G = MODULUS OF TORSIONAL ELASTICITY = 14,500,000. P = LOAD IN LBS. D = MEAN DIA OF COIL = D1 − d. d = DIA. OF WIRE
F = 8 P D³ / G d⁴ DEFLECTION OF ONE COIL PER 100 LBS. = 1/18125 D³/d⁴
MEAN DIAMETER OF COIL D = D1 − d
DEFLECTION PER COIL PER 100 LBS.
DIAMETER OF WIRE d
Machinery, N.Y.

Diagram showing Deflection of Coil Springs.

Chart No. 2 was then constructed, the side representing values of S being adjacent to chart No. 1, S being taken as the first factor. The second factor is $\frac{1}{2.55\,D}$, thus the top of chart represents $\frac{S}{2.55\,D}$. The other set of sloping lines marked d represent the value of d^3 and perform the operation of multiplication, thus giving value of P in formula, $P = \frac{S\,d^3}{2.55\,D}$.

Chart No. 3 was then constructed by projecting points from No. 2, thus $C\,D\,G\,G\,H\,I\,J$ and $C\,K\,L\,L\,M\,N\,O$ show the projection for points on the curve which represents $d = 1/4$-inch. Chart No. 3 is thus complete in itself, Nos. 1 and 2 being used only in developing the curves.

Desired: A chart for helical springs of round steel, giving the deflection.

Begtrup's formula is $F = 8\frac{P(D_1 - d)^3}{E\,d^4}$. Taking E at 14,500,000, as stated by Prof. Benjamin, the deflection for one coil per 100 pounds = $\frac{1}{18125}\frac{D^3}{d^4}$. Chart No. 4 shows to a small scale the construction and development of curves in Chart No. 5. The top of chart No. 4 represents values of D^3, the sloping lines values of $\frac{1}{18125\ d^4}$ and perform the operation of division, thus the side gives the deflection = $\frac{1}{18125}\frac{D^3}{d^4}$.

Points were projected into a smaller and more convenient chart on the right giving the curved lines shown. Thus A projected to B gives a point on line $D = 6$ inches, which curve representing 5/8-inch diameter wire passes through. Chart No. 5 gives these lines to a convenient scale for interpolation.

While the formulas read mean diameter, if it were thought advisable to have the charts read outside diameter this could be readily accomplished by shifting each curve when tracing.

THE "DE FRIES" PRECISION LATHE.

DR. ALFRED GRADENWITZ.

Dr. Alfred Gradenwitz.

In a precision lathe recently brought out by the firm of De Fries & Co., Düsseldorf, Germany, there is applied a novel construction in place of the usual lead screw by which it is claimed that extreme accuracy is obtained so that screws of any desired length may be cut of very accurate pitch.

Heretofore thread cutting has simply consisted in copying an existing lead screw, the latter being in turn copied from a master screw. There has been a serious drawback in this method, however, for producing accurate threads, because it has been extremely difficult to procure a master screw of uniform pitch, and any error in the pitch would be reproduced in the second screw. Now the De Fries lathe is quite independent of any existing screw, since a *lead nut* cut in halves longitudinally, thus making a long half nut, which is used in place of a lead screw. This nut runs along the bed of the lathe, and a bronze screw forming part of the mechanism of the carriage meshes with the threads of the nut. The screw is driven by change gears and a splined feed shaft located in the usual position, below the lead nut, as shown in the illustration. The thread grooves of the nut are cut singly by means of a special patented apparatus. As soon as a single thread has been made, the tool is moved most accurately as far as the next division by aid of a measuring instrument of precision. Any threads finished by the aid of the lead nut according to the method above are obviously copies of the same; and as the nut is finished with practically mathematical accuracy by means of a precision measuring machine, any thread cut by the novel lathe will also be of nearly mathematical precision.

Other advantages over the old system may be mentioned, *i. e.*, the slide rest drive is placed as near as possible to the shears and the driving force thus acts directly under the tool post, and as near to the cutting point of the tool as it is possible to locate it. This produces the smallest possible twisting moment and gives a very direct drive. Again, whereas with previous lead-screw lathes the lead screw would frequently undergo heating and expansion because of the friction and pressure, this constituting a great drawback to accurate thread cutting, any heat evolved in this part of the mechanism of the De Fries lathe is conducted to the bed of the lathe and thus dissipated. Still another point is that in gap lathes, which are so much used on the continent, it was necessary to locate the lead screw in a very low position in order to clear the gap, and thus the driving force acted upon the slide rest at a great distance from the cutting tool. In the De Fries lathe this is avoided, as shown in the second illustration, since the lead nut does not have to extend across the gap and the splined driving shaft is located low enough to clear the gap. On account of the wear of the lead screw being obviously the greatest in the neighborhood of the face plate, lathes of the old type lost their accuracy after a brief use, since there would be a change in the pitch in passing from a point near the face plate to a point where the lead screw had retained its original accuracy. In the De Fries lathe the lead nut is made up in several sections, any one of which may be renewed so as to correspond exactly with the other section. In this way the ability of the lathe to cut threads of accurate pitch can be maintained with no great trouble or expense.

In its general design and construction the lathe is built with the utmost care, every refinement of modern workmanship having been made use of. Special points have been made of neatness of construction, easy handling, beauty of appearance, and stability. The lathe is, by the way, heavy enough so that it is especially adapted to the use of high-speed steels. The lathe bed has T-shaped walls of extraordinary breadth and height, joined by means of hollow braces. The shears are broad and rectangular and special provision is made for oil-

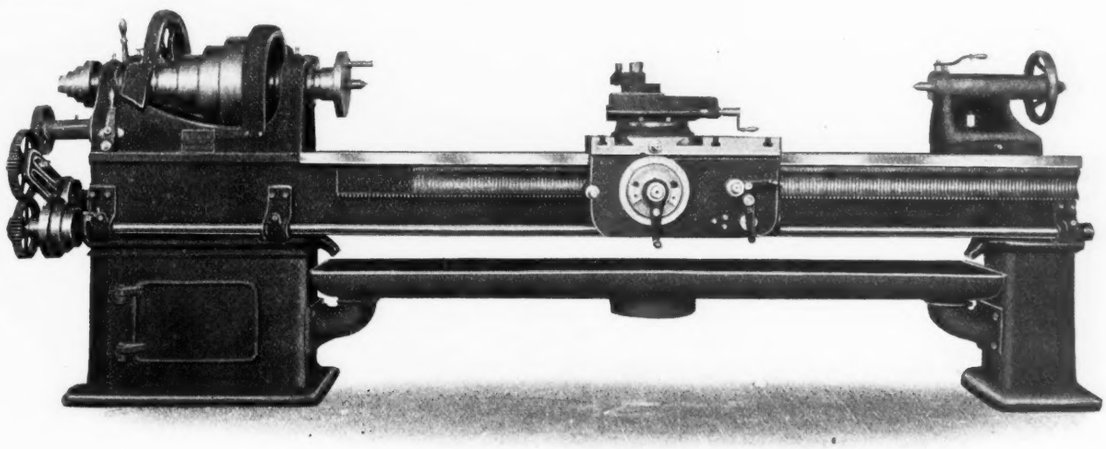


Fig. 1. De Fries Precision Lathe with Lead Nut, extending the Length of Carriage Travel, in place of a Lead Screw.

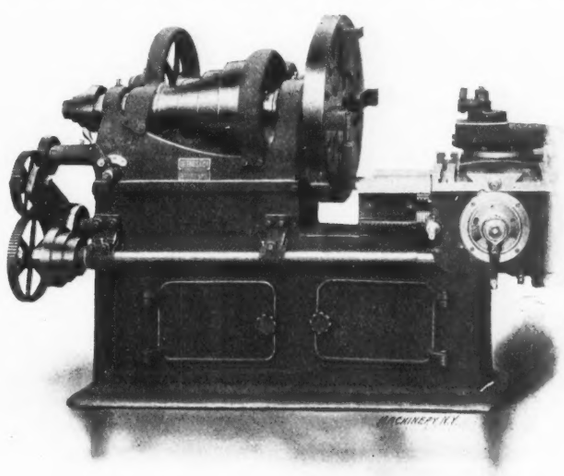


Fig. 2. The "De Fries" Principle applied to a Gap Lathe. With a Lead Screw on a Gap Lathe the screw has to be dropped below the gap, but not so with the Lead Nut.

DR. ALFRED GRADENWITZ was born at Breslau, Germany, May 18, 1875. He was educated at the König Wilhelm's Gymnasium (Preparatory School), Breslau, the Technical High School, Carlottenburg, and at the universities of Breslau, Freiburg, and Geneva. Dr. Gradenwitz has made a special study of science applied to industry and the progress of science and industry. Hence he has naturally become a contributor to the technical press; his contributions have been published in the leading trade papers of Germany, France, Spain, Norway, Denmark, Great Britain, and the United States.

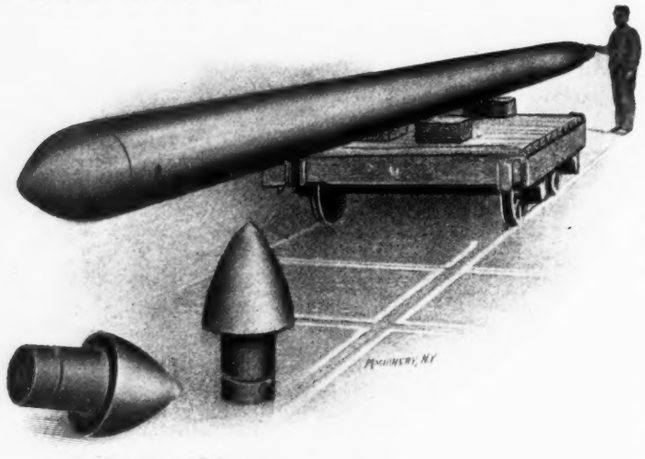
ing automatically, the oil coming in contact with the friction surfaces while the slide is moving.

The headstock is of pleasing shape, of strong and massive construction, provided with a four-stepped cone pulley for a wide belt. The gearing is protected by cast-iron covers. There are also tumbler gears located in the headstock by which the direction of feed is changed and there is a shift gear to enable extremely coarse threads to be cut. The lathe spindle is hollow and of crucible steel and the bearings are of phosphor bronze cut longitudinally into three parts spaced 120 degrees each. The thrust of the lathe spindle is taken by several chilled disks, between which are disks of a special composition. This arrangement was chosen after many experiments. The slide-rest and carriage have long, broad sliding surfaces so as to eliminate vibrations, even under heavy strains. Both the longitudinal and transverse feed screws are provided with graduated dials. The feed mechanism is of novel arrangement and either transverse or longitudinal feeds may be worked automatically or by hand, and the screw and rack feeds block each other so they cannot be operated simultaneously.

* * *

EFFECTS OF WAR ON THE ARTS OF PEACE—LOBNITZ ROCK CUTTER.

However much we may deplore the cruelty and waste of war, it is easy to show, paradoxical as it may seem, that war and the fear of war (and its consequences) have been powerful factors in stimulating inventive genius and constructive arts. The ancient armorers were, in effect, subsidized workmen who received very large sums for their products as compared with the prevailing prices for other goods. Hence the developing effect of war upon the metal-working arts. So in later years the building of battleships, rifled guns, mounts, the manufacture of the munitions of war, have undoubtedly reflected great benefits in civilizing influences, although the making of such is economically wrong. No cost is considered prohibitive by powerful governments in gaining a desired improvement, and the consequent experimenting and constructive work is happily not altogether waste effort—because of its beneficial effect on other lines of work.



Lobnitz Rock Cutter.

An interesting example of the beneficent effect of the arts of war upon the quiet pursuits of peace is shown in the cut which shows a huge rock cutter made by Lobnitz & Company, Renfrew, Scotland. This device is made for breaking up rocks under water as is necessary in harbor dredging operations, canal work, etc., and is found far more effective and cheaper than drilling and blasting operations. The cutter usually weighs from 10 to 15 tons and resembles an elongated armor-piercing projectile. The similarity is further carried out in that the head is made of steel of about the same characteristics as found in armor-piercing projectiles. These immense cutters or breakers are raised to a height of 6 to 10 feet and allowed to drop by a suitable releasing gear, the lifting apparatus being a steam winch or hoisting engine of special design for this work. As the cutter falls, the impact of its tremendous blow is concentrated upon a few square inches of rock surface, and the hardest granite yields readily to such forceful treatment. The fact that is of first importance in this connection is that until steel of the characteristics that make a successful armor-piercing projectile was developed, such a tool would have been a virtual impossibility since no ordinary tool steel could stand the punishment. This tool will probably play an important part in the completion of the digging of the Panama Canal, and this inspires the question: Who knows what the effect of high-speed steel will eventually be upon the peaceful pursuits of the world, and this was discovered and developed in the manufacture of armor plate and the machinery of battleships.

* * *

DRILL SPEEDS TABLE.

The table herewith, contributed by Mr. Walter Brown, Chicago, Ill., gives the speeds of drills in steel, malleable iron, cast iron, brass and tool steel, have been found most practical, in general use, at the Chicago works of the International Harvester Company. These speeds were carefully compiled after thorough trials in the works, and have been found to be good commercial practice. It will be noted that the small drills are given a greater peripheral speed than the large drills. To compensate for the greater speed, the feed of the small drills is correspondingly reduced, this being found to give the most satisfactory results.

SPEED OF DRILLS.

Size of Drill.	Revolutions per Minute.				
	Steel.	Mall. Iron.	Cast Iron.	Brass.	Tool Steel.
1/16	3650	4200	4380	6950	1790
1/8	1540	1770	1850	2930	755
3/16	1060	1240	1270	2160	520
1/4	740	850	890	1410	382
5/16	570	655	685	1080	280
3/8	460	530	550	875	225
7/16	370	425	445	703	182
1/2	310	356	372	590	152
9/16	270	310	324	513	132
5/8	240	276	288	456	118
11/16	210	242	252	400	103
3/4	188	216	226	358	92
13/16	170	196	204	323	83
7/8	156	180	187	296	76
15/16	142	163	171	270	70
1	134	154	161	255	66
1 1/8	115	132	138	218	56
1 1/4	104	120	125	198	51
1 3/8	92	106	110	175	45
1 1/2	84	96	101	160	41
1 5/8	75	86	90	145	37
1 3/4	70	81	84	136	34
1 7/8	63	72	76	120	31
2	59	68	71	112	29

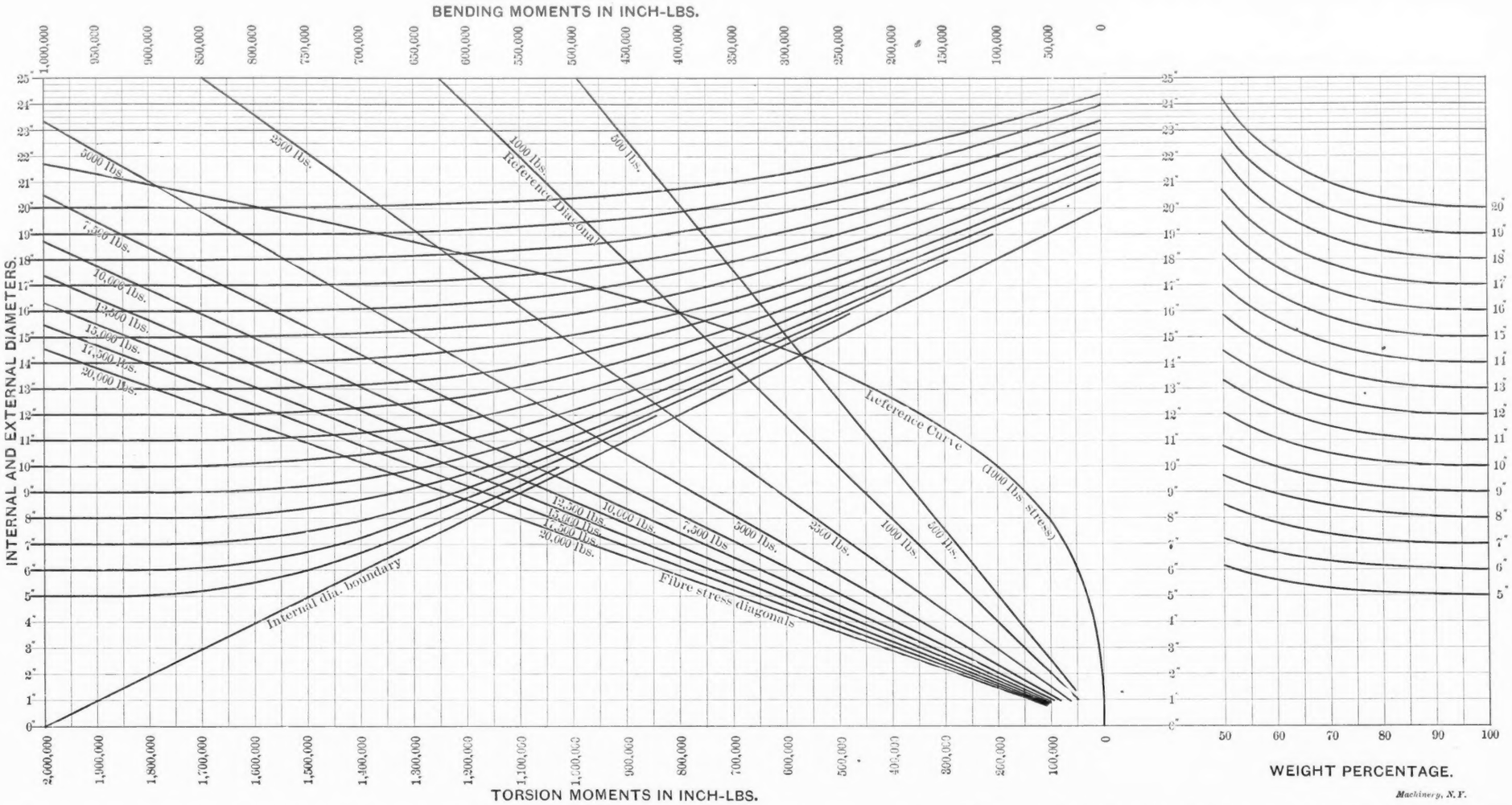
* * *

CHART FOR HOLLOW AND SOLID SHAFTS.

The diagram, next page, is one of the United States Navy standard charts of which several have been published in data sheet form in recent numbers of MACHINERY. The chart is for the purpose of finding the dimensions of shafts, especially of large size, as used in marine and heavy stationary engine construction. It can be applied to both solid and hollow shafts, when subjected to either torsional or bending stresses. The shaft diameters are found by first selecting the bending moment (at the top of the diagram) or the torsion moment (at the bottom of the diagram) which applies in the particular problem, and then proceeding as follows:

Solid Shaft in Torsion.—For a torsion moment of 1,600,000 inch-pounds and a maximum fiber stress of 7,500 pounds, follow the 1,600,000 torsion moment line vertically to the "reference curve;" trace the intersecting horizontal to the "reference diagonal;" trace the intersecting vertical to the 7,500-pound fiber stress diagonal and finally the intersecting horizontal to the vertical scale at the left-hand edge of the diagram, finding 10.27 inches diameter for the shaft.

Hollow Shaft in Torsion.—First find the diameter of a solid shaft to carry the load, as above, and assume some inside diameter. Suppose the outside diameter for a solid shaft is



found to be 10 inches and the inside diameter of a hollow shaft of the same strength to be assumed at 7 inches. To obtain the required outside diameter of the hollow shaft, start at the left at 7 inches and follow the horizontal line until the internal diameter boundary diagonal is reached; then proceed vertically upward until the curve is intersected which starts at the 10-inch point on the scale at the left, and read the diameter corresponding to this point of intersection. The diameter found is 10.75 inches; a shaft of this diameter, and with a 7-inch hole through its center, would have the same torsional strength as a solid shaft 10 inches in diameter. Again, if the central hole were to be 8.75 inches diameter, the outside diameter would have to be 11.5 inches in order to give the same strength as a solid 10-inch shaft. The diagram is so constructed that all shafts having external diameters bounded by the curve starting at 10 inches at the left and having internal diameters bounded by the diagonal starting from 0 at the left, are equivalents, and the same is true for curves starting from other points on the scale at the left. The vertical height from the diagonal bounding the internal diameters to the curve bounding the external diameters, is the actual wall thickness. drawn to a reduced scale, and is useful as giving a graphic comparison of the various equivalent shafts.

Weight Relation of Shafts.—To find a hollow shaft to have 50 per cent. of the weight of its 10-inch solid equivalent: Follow the 10-inch shaft curve in the small diagram at the right to the point of intersection with the 50 per cent. vertical line; then proceed horizontally to the 10-inch diameter curve in the large diagram at the left, which it intersects at the sought-for external diameter of 12.125 inches; and finally, dropping vertically down from the intersection point to the internal diameter boundary line, gives a diameter of 9.75 inches for the hole.

Shafts Subjected to Bending.—Proceed as before, but use the bending moment scale.

LETTERS UPON PRACTICAL SUBJECTS.

WONDERFUL TAPS AND DIES.

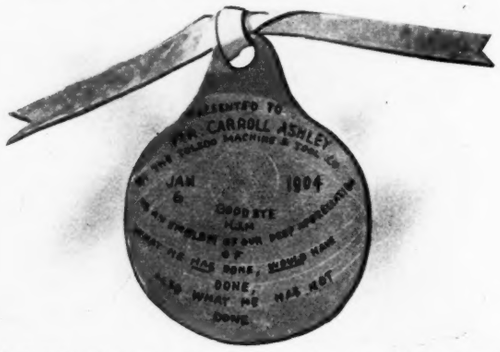
Editor MACHINERY:

Recently an English daily newspaper of good reputation for reliability announced with befitting seriousness that taps and dies were now made so small that they could tap the human hair. After reading this I pictured to myself the advertisements of future tonsorial establishments: "Why have short hair? Tresses lengthened in any degree by our new process. Threads warranted without backlash and not to strip." Indeed, the prospect seemed so rosy that I thought of going in for the business myself and of getting the necessary kit. But, unfortunately, like the majority of the wonderful announcements in this "something scientific" column, there was neither the price, maker's name, or any practical information given for these useful (?) tools. However, if you know where I can get any of these I should be very glad of the information under "How and Why." When a paper wanders out of its depth it should be careful as to the source of its news. MCANIC.

A LEATHER MEDAL.

Editor MACHINERY:

Since we were "knee-high to a grasshopper" we have often heard the expression: "You ought to have a leather medal," More especially is the expression used in the machine shop, but have any of the readers of MACHINERY ever seen one? Methinks not a great many, not perhaps that some of you have not deserved one many times, but don't it recall to your memories many incidents of shop life—some humorous and some otherwise—just to remember some certain event, when for doing something famous or infamous you were threatened with the bestowal of a "leather medal"?



A Leather Medal given to Mr. Carroll Ashley, as a token of good fellowship, when leaving the Toledo Machine & Tool Co. after a seven years service.

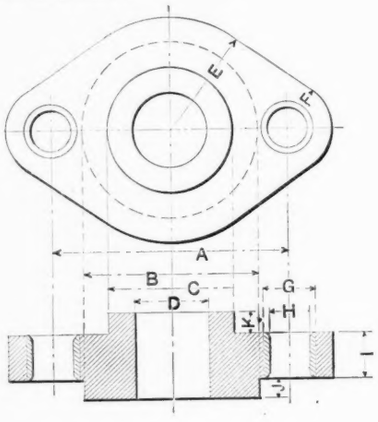
I take pleasure in sending you a photo of an identical "leather medal"—the real thing—not perhaps a thing of beauty, but it may be a joy forever, to me at least, as whenever I recall the episode of its presentation, I smile. It is made of four-ply unadulterated leather, a neat bow of "belt lace" gives it a machine shop effect. Though the inscription is rather vague it seemed to fill the bill. As much pomp and ceremony were used on its presentation, as if the recipient were going to be presented with a house and lot, and, in the same spirit, I endeavored to answer the presentation speech (which was long and quite flowery) just as if I had received the real estate. However that may be, the fact remains that I am the possessor of a real "leather medal;" if any of the readers of this journal can make a similar boast, I might be tempted to exchange condolences with him. CARROLL ASHLEY.

Rochester, N. Y.

"LABOR-SAVING SCHEME FOR MAKING DRAWINGS."

Editor MACHINERY:

In Mr. C. W. Putnam's article "Labor-Saving Scheme for Making Drawings" in the September number of MACHINERY, I do not think he has chosen a very good illustration of the use of templates in the drawing-room. He was obliged to make a pencil-drawing in the first place. Then, while he was cutting out the template, he could have put a piece of tracing cloth over it and traced it, or this would have been a good job for the blueprint boy. Letters would then have been put on for dimensions, and while he was packing up his five sheets of tracing paper with the carbon sheets between, a row of columns could have been ruled off under the figure. At the head of the first column could be put "No. of Gland," and the letters corresponding to the dimensions at the heads of the others. He would then have something permanent and it would have taken little longer, if any, than for him to make his first five copies. It will take no longer to fill in the dimensions for the different size glands on the tracing than it would on his sketches, and if he printed the same title, as shown, on each sheet he would be left far in the rear before he had made the five hundred. I was about half an hour making the drawing for the accompanying cut; how many carbon tracings of his first five hundred could Mr. Putnam have made in that time?



NO. GLAND	A	B	C	D	E	F	G	H	I	J	K
60	$4\frac{3}{4}$	$3\frac{1}{2}$	$2\frac{17}{32}$	$1\frac{1}{4}$	2	$\frac{7}{8}$	$1\frac{1}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{8}$

Machinery, N. Y.

"Labor-saving Scheme for Making Drawings."

I object to putting pencil drawings out in the shop for several reasons:

First, it is my experience that they are so hastily made that many of the important dimensions are often omitted, causing the workman, or perhaps the foreman while he stands around, to run back to the draftsman, or his chief, and interrupt him in some important calculation. Second, mistakes are more common on pencil tracings than on finished drawings. Third, if a workman makes a mistake on the work he can easily change the figure on a sketch, and sometimes does. Fourth, if the sketches are ever returned to the drafting room, which is doubtful, they are covered with grease and dirt and badly mutilated. Fifth, the sketches are generally of all sizes and shapes and are very difficult to file away or put anywhere where they can be readily found when wanted.

While it sometimes becomes necessary to use such sketches let us avoid it wherever possible. While I believe in doing

just as little work as possible, and that in the quickest and cheapest way we can, do not let us do it in such a way as to cause us weeks of sleepless nights and to be "blessed" by everyone connected with the concern we are working for, some time in the future.

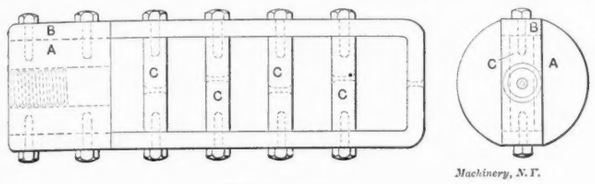
Templates can very often be used to advantage, but great care must be taken to get the work accurate. One cut out of cardboard or sawed from a ¼-inch board, is not good enough for complicated machines, such as a loom, drawn one-fourth size. It should be laid out on zinc under a magnifying glass and then filed up by a man who can work right to a line.

Worcester, Mass. H. A. HOUGHTON.

WIRE STRAIGHTENER.

Editor MACHINERY:

In reply to inquiry by "Connecticut" for a wire straightener I send sketch and description of one I made about seven years ago to straighten ⅛-inch spring wire. It consists of a cast iron piece, *A*, fitted to the spindle of a speed lathe, and having two slots milled on the side for the piece of machinery steel *B*, which is bent U-shaped as shown. This frame holds a number of tool steel pieces (in this case four), which have



Wire Straightener.

holes drilled through them slightly out of center. After being hardened, drawn and the holes lapped to smooth them, they are assembled on the frame so as to bring the small holes in the position shown. One end of the wire is pushed through the four holes and through the hollow spindle of the lathe until it can be grasped with a pair of pliers, when the lathe may be started and the wire pulled through slowly.

New York. H. J. BACHMANN.

HOW BILL CHANGED HIS JOB.

Editor MACHINERY:

One of my old shopmates came in to see me the other day. He had been away from the shop for two years or more and I had not heard a word from him in that time and I was cordially glad to see him. He wasn't much of a machinist; he never wore overalls or a jumper, and he used to turn his shirt away back from his neck and cut off the sleeves at the shoulder, and he didn't look like a machinist any how. He had been in the shop two or three years and he never got over $12 a week, and one day "he chucked up" his job and lit out—said he was going to see if he couldn't get a living at something that suited him better, or that he was better suited for, and as soon as he came in the other day, I saw at once he had found it. He had on a blue suit, not the "dollar-down-and-a-dollar-a-week style," but one that looked as though he had been melted and poured into it. A nice yellow chain hung out of his vest pocket and I knew Bill well enough to know there was a watch to match on the other end of the chain. He had on a clean collar and he looked like a man who had found prosperity.

"Well, Bill, you look as though you had struck oil," I said as we shook hands.

"No, but I have struck something that is better than oil and that is a hole that fits me," and then he went on and told me what he had been at.

When he "jacked up" he had no idea of what he was going to do and he took a job as deck hand on one of the steamers between Fall River and New York at $20 a month, and put in three months at it. Then went two trips as a coal passer and fireman on one of the big ocean liners at a pound a trip. He made two trips and no amount of money would tempt him to make a third. Then he shipped as fireman on a United States transport to Manila at $55 a month. That was a good thing, and he made three trips on her from San Francisco to Manila and return. Here he found that in order to cut any ice, he must be a union man, and so he joined the Fireman's Union and shipped for the Yukon River at $90 a month. Just before he went, he saw an illustration of the power of a union that will stand repeating.

An English firm had taken a contract to carry the United States mails from San Francisco to some foreign port and by the contract the steamer must be manned by American seamen, so the captain let his "long-haired boys" (Chinese) go and came up to the hall of the Fireman's Union to get a new crew. The captain had but one eye, and he called out the master fireman and says, "I want a crew of eight good firemen and I will pay seven pounds five shillings per month." This was a big price for an English boat, but it did not go at all.

"No you don't, if you want a crew out of this hall, you will pay ten pounds straight.

"What!" said the captain, and the mate who was with him roared, "What! pay a lot of greasy coal slingers two pounds a month more than I get; I won't stand that."

The captain started off and saw the British consul, only to be told that if he had taken a mail contract with that clause in it, he must take union men, and take them he did at ten pounds a month.

After three months on the Yukon, Bill struck a berth as second engineer at $110 a month, and although he had no papers, he held it till he could some back to 'Frisco and get passed. His machine shop training told in the examination and he got his papers and then came East to see some of his old friends and to go out as second engineer with a new boat just being finished.

"And now," said Bill, "if you know of a machine shop where I can earn $110 a month, a clean bunk and three squares a day, I am ready to talk, but till then, good-bye."

Bill has gone, but his experience lingers with me yet, and I can't help thinking how nice it would be if all the boys could find a hole that they fitted into as well as Bill has.

A. P. PRESS.

THREE-PIECE ELLIPSOGRAPH.

Editor MACHINERY:

To test the principle of an elliptical chuck we made the model shown herewith by means of which it was possible to trace with a stationary pencil, an ellipse of any size or proportion, on the revolving platen.

Fig. 1 is the base or stationary part, and it consists of a piece of 1¼-inch pine about 16 inches square, having a slot

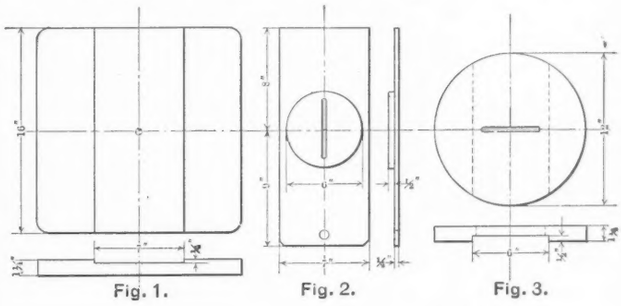


Fig. 1. Fig. 2. Fig. 3.

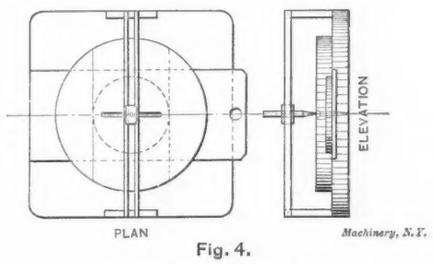


Fig. 4.

Three-piece Ellipsograph.

about 7 inches wide and ¼ inch deep across the center of the upper side. Into this slot is placed the piece for adjusting the eccentricity of the ellipse. This part is shown in Fig. 2 and consists of a piece of ¼-inch pine with a disk 6 inches diameter and ½ inch thick attached to its upper side. Fig. 3 shows the platen, which is 12 inches diameter, with a groove 6

inches wide and ½ inch deep across its under side. This groove fits over the 6-inch disk, shown in Fig. 2. The whole apparatus is held together by a large wood screw passing through Fig. 2 and Fig. 3 into the center of Fig. 1. Two small strips are supported from the base and run diametrically across and about 2 inches above the platen. A small block supporting a lead pencil, slides between these strips, as shown in the assembled drawing.

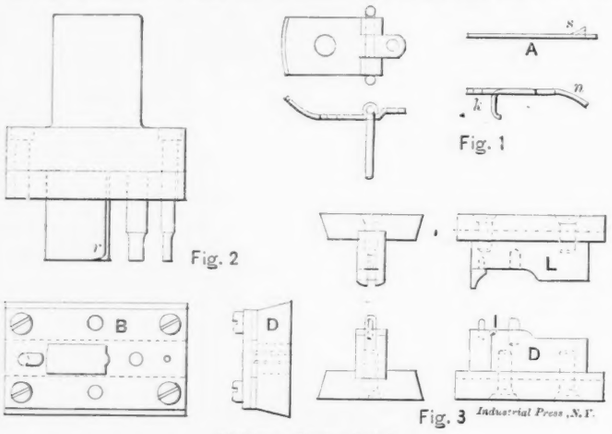
To operate a paper is tacked on the platen. The piece shown in Fig. 2 is drawn to the right according to the eccentricity desired and the pencil pushed away from the center, according to the minor axis desired. Upon rotating the platen by hand an ellipse will be traced. As any proportion between the minor and major axes can be obtained the apparatus was later used with a cutter instead of a lead pencil, which gave good results in cutting photographs, etc. J. D. ADAMS.

Phoenix, Ariz.

MAKING A SPRING LATCH.

Editor MACHINERY:

I send you herewith descriptions and drawings of dies for making the spring latch shown in Fig. 1. Fig. 2 shows the blanking punch and die, which is of the ordinary follow type, the only special feature being that the punch is rounded at *r* to start the two wings for curling. *D* is a cross view of die,



Making a Spring Latch.

while *B* is a plan view. *A*, Fig. 1, is the blank as it comes out from this operation. Fig. 3 is the splitting die for turning up the two ends as shown at *k*, Fig. 1. The blank *A* is laid on the die *D* with the bent ends *s* pointing down over the bending forms *I*. The punch *L* descends, bending the ends down as shown at *k* in the lower view of Fig. 1, and curving the back of the latch as shown at *n*.

We will next consider the staple die, Fig. 4. The wire being laid in the die as shown, the punch descends and the knife cuts the wire off at *C*. The punch, which is ⅛ inch shorter than the knife, pushes the wire, which is left lying in the groove against the stop pin *G*, down into the forming grooves *O O*. Then the punch rises and with it the spring stripper *R*, thus ejecting the staple when the wire is inserted in the die again and the operation repeated. This die is used in an inclined press, which causes the staples to fall by gravity after being formed. End views of the punch and die are shown at the right.

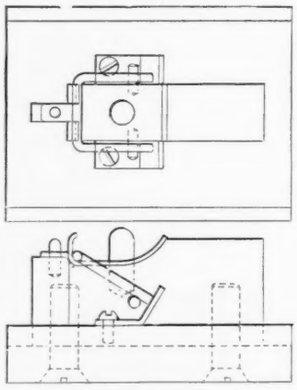


Fig. 5.

We are now ready to curl the two wings *k*, Fig. 1, over the staple, and for this purpose the punch and die, Figs. 5 and 6, were made. The punching *A*, Fig. 1, is laid on the die as shown with the ends resting on the holders on either side of the die. The punch in descending strikes the blank with the spring foot, which holds it in position while the curling punch coming on down forms over the ends *k*, Fig. 1, around the staple. At the end of the stroke, the tongue is formed over

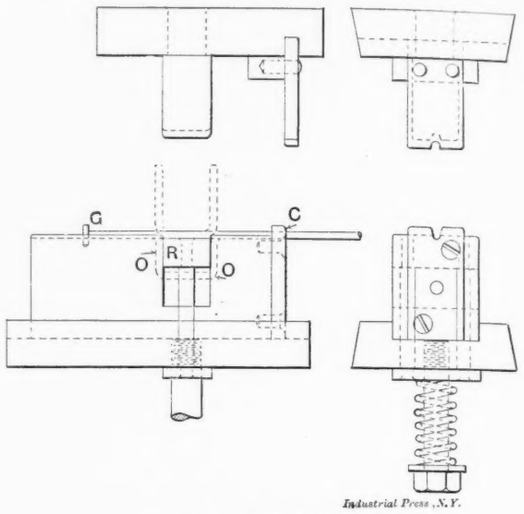


Fig. 4. Staple Die.

the raised die by the punch, thus completing the latch. I have not thought it necessary to explain the construction of the tools as it is made quite plain by the drawings.

H. R. H.

CATCHING THREADS AND GAGING THE DEPTH.

Editor MACHINERY:

I noticed the remarks by John A. Burgess in the June issue and it carried my thoughts back to the days when I was an apprentice. As regards the knot holes in the wall, they were about the same, and I also had to take a broom in the winter and sweep the snow off the lathe after a storm that leaked through these same knot holes or some other aperture that was more convenient for the sparrows than the men.

Now, in this same shop I learned a method of cutting threads that may be interesting to your readers, and it was this: I used to carry the carriage back without stopping the lathe at all. I don't mean on a thread that was the same pitch as the lead screw, but I mean any thread, and I also mean long ones where the carrying back of the carriage was a great saving of time, and I very seldom made a mistake. It may seem a difficult operation, but it is simple when the idea is understood. All it requires is to regulate the speed at which

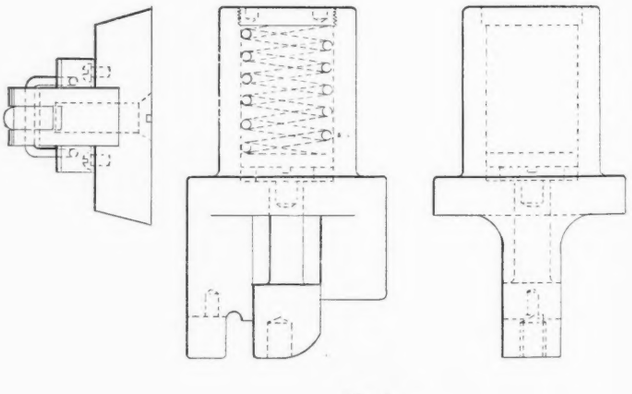


Fig. 6.

the carriage is run back, by the length of the screw and the pitch. Now I used to put a chalk mark on the faceplate and another on the lathe bed at the end and beginning of the thread and far enough away to give me a chance to feed in the tool to the depth required. It is just the same as suggested by Mr. Burgess, only there are points that require a little explanation, for there are a great number of men still

going around that know of no other way than pulling back by hand or power, both of which are a lot of lost time. For example, if I am cutting 8 threads per inch and the tool has reached the end of the thread and my mark on the faceplate has come into view I disconnect the split nut, and with the lathe still running I carry back the carriage at the same time, counting in my mind 1, 2, 3, 4, etc., every time the mark on the faceplate comes in to my view. If I reach the starting of my thread in time to catch the fourth revolution of the faceplate I connect nut again and start afresh; if not I count up to 8, do the starting again from that point.

Now this brings me to another point, and that was the plan I employed to set the tool to the required depth in cutting. When I took the first cut I would notice in what position the handle stood, and we will say that it stands straight up. I would say to myself that it was at 12 (or you could call it anything you liked, but I used to say 12). Now the next cut I would call 5 past 12, and the next would be 10 past, and when it was 15 past the handle would just be one-fourth the way around. You see the handle I treated like the hands of a clock, and with a little practice it is surprising how accurate one can be, and when he gets familiar with the spacing he can finish the thread by counting single minutes. Now this may seem crude to some of your readers, and to some it may be new, but judging by the number of readers of MACHINERY about here you must have both kinds. To those who try this method they will be surprised at the rapidity at which they can cut threads compared to what they did before.

BARNEY.

BORING BAR FOR CHASING THREADS.

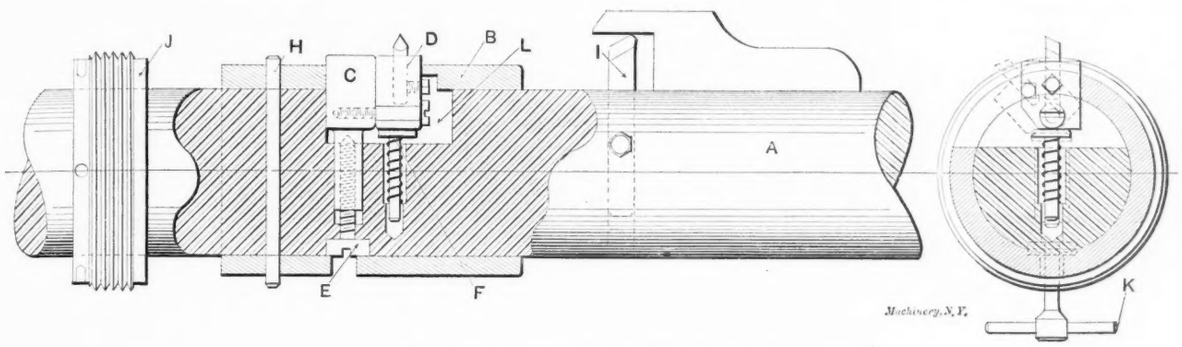
Editor MACHINERY:

Herewith is a sketch of a combined boring and thread-cutting bar, which was designed for boring and threading the large crossheads of the engines, which were built for the Brooklyn Rapid Transit Co., Brooklyn, N. Y., by the Allis-Chalmers Co., Scranton, Pa. The holes in these crossheads, when finished, were 8 inches in diameter by 12 inches long and threaded 6 per inch. The material used was Bessemer steel.

The bar *A*, in Fig. 1, is 8 feet long by 5½ inches in diameter, with a portion, marked *L*, cut away and two holes drilled to receive the feed slide, and the pawl which retains the tool block in position, as is shown in Fig. 4. The sleeve *B*, Fig. 3, is fitted to the bar and secured by the pin *H*. This sleeve is slotted to allow the feed slide *C* and the tool block *D*, Fig. 1, to move to the work and also to hold the tool block rigid, when cutting. The slot is cut sufficiently off the center to allow the tool block to be swung to one side when the cut is through, as shown by the dotted lines in Fig. 2. The workman, by disengaging the lead nut, can run back the lathe carriage to which the work is bolted, turn the tool block back into cutting position, feed the tool out, by means of the wrench *K*, Fig. 2, and take the next cut, repeating this until the hole is finished. The threaded collar *J*, Fig. 1, is a gage for sizing the thread without taking the bar out of the lathe, being made the exact size of the thread on the piston rod. *I* is the cutter (under the setting gage) for boring the hole before chasing the thread. The sleeve *B*, overlaps the head of the feed screw *E*, and takes the end thrust. The tool block *D*, swings on the pin *L*, and is held in the desired position by the flat spring-pawl *F*. The merits of this tool may be seen at a glance, and I will say that it made a very good job of the crossheads.

D. LINDSAY.

Plainfield, N. J.



Figs. 1 and 2. Boring Bar for Chasing Threads.

CHANGE GEARS FOR DIAMETRAL PITCH WORM TEETH—CUTTING MULTIPLE THREADED SCREWS.

Editor MACHINERY:

While it is customary to design worm gears by the circular pitch system, for convenience in finding the proper change gears for threading the worm in a lathe, yet occasionally the workman may have the problem of calculating the change gears required for a worm of the diametral pitch system. In such cases it may conveniently be done as follows. Multiply the ratio of the pitch (in threads per inch) of the lead screw of lathe, to the diametral pitch of wormwheel, by 3.1416 or (to avoid decimals), by 3 1-7. This will give the ratio of the stud gear of lathe to the screw gear. For example: Required the change gears to thread a worm of 6 D. P. the lead screw of lathe having 4 threads per inch.

$$\frac{4}{6} \times \frac{22}{7} = \frac{88}{42}$$

88 = gear on stud.
42 = gear on screw.

The above gears will give the required lead, with an error of not quite 0.0002 inch in the thread of worm, and is caused by multiplying by 3 1-7 instead of 3.1416, which would give a fraction of a tooth or $\frac{87.9648}{42}$. Perhaps a better way to remember the rule would be: Multiply the threads per inch in lead screw of lathe by 22 and the diametral pitch of worm-

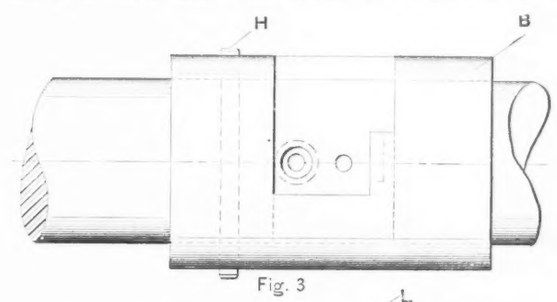


Fig. 3

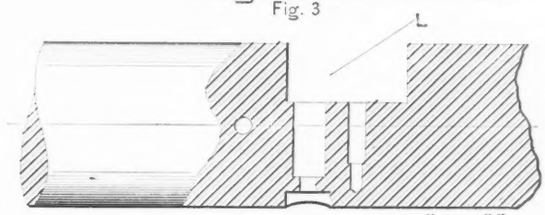


Fig. 4

Section of Boring Bar for Chasing Threads.

JOHN T. GIDDINGS was born in St. Johns, New Brunswick, June 18, 1865. He has a commercial education and is a graduate of the International Correspondence School. He served an apprenticeship with the Providence Machine Co. and the Rhode Island Locomotive Works. Besides these concerns he has worked for the Builders' Iron Foundry, the Brown & Sharpe Manufacturing Co., the Corliss Steam Engine Company, the American Screw Company, the American Ship Windlass Co., and others. His specialty as a machinist is lathe work; and as a draftsman, hoisting machines and windlasses.

wheel by 7. This will give the ratio of stud gear to screw gear. The above rule assumes that the stud of lathe makes the same number of revolutions as the lathe spindle. If it does not, then the equivalent pitch of lead screw should be used as explained by Mr. Fred H. Colvin in the November, 1903, issue of MACHINERY.

When a multiple threaded screw is to be cut in a lathe, if the faceplate is not divided into the required number of slots for shifting the driver (or dog) the usual method is to disconnect the change gears and either move the spindle through the required part of a revolution, or the gear on the lead screw may be moved enough to cause the required amount of tool travel for the next groove to be cut. For some cases this may be more conveniently done as follows: Calculate the amount of travel required for the tool to cut the next groove, then (the lathe being stopped) disconnect the lead screw half nuts, and move the carriage by hand the required amount, provided, of course, that the lead screw is of such a pitch as will admit of this method. For example: Required to thread a triple-threaded screw of ¾ inch lead. The lead screw of lathe has 4 threads per inch or ¼ inch lead. After cutting each groove, disconnect, and move the lathe carriage one thread of the lead screw, this will bring the tool in the proper position for the next grooves. For some cases this is not quite so easy, as for example: Required to cut 6 threads per inch, double; the lead screw same as before, ¼-inch lead. Then the lead of screw to be cut is 1-3-inch and the pitch of thread or the distance to move the carriage is 1-6-inch. We cannot move the carriage 1-6-inch and catch the thread with a ¼-inch pitch lead screw, but it may be moved 3-6 or ½-inch, which will bring the tool in the proper position for cutting the second groove. For still other cases the pitch of the lead screw may be such as not to allow the above method to be used at all, but the principle having been explained the reader will have no difficulty in determining whether such is the case.

JOHN T. GIDDINGS.

East Providence, R. I.

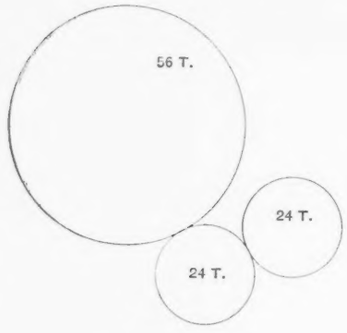


Fig. 1.

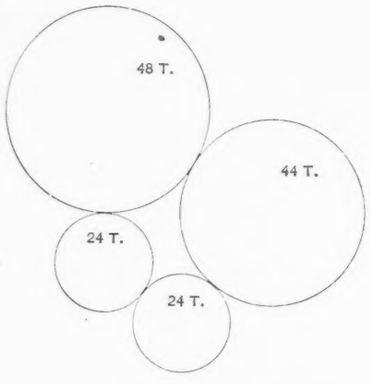


Fig. 2.

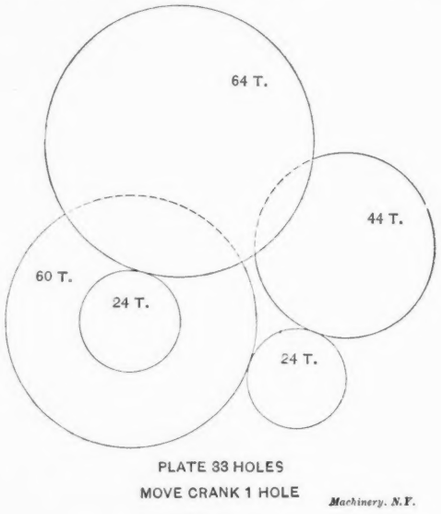


Fig. 3.

FORMULAS FOR DIFFERENTIAL INDEXING.

Editor MACHINERY:

In differential indexing the index circle is geared to the spindle so that, as the crank moves, the index circle also moves either clockwise or counter-clockwise, depending on whether we use one or two idlers. This motion of crank and index circle at different rates, and in the same or different directions, allows us to cut any number of divisions, exactly, without compound indexing. This method is called differential indexing.

To obtain a formula for determining the gears necessary to cut a given number of divisions we proceed as follows: If N divisions are to be cut, the spindle will rotate $\frac{1}{N}$ turn between each division; also the distance traversed by a hole of the index circle $\pm$ the distance traversed by the crank equals the number of turns, or part of turn, of the index circle.

If, then, we let $x:y$ be the ratio of the teeth of gear on spindle to the teeth of gear on worm, and if the crank turns 40 revolutions to one of the spindle, we can then obtain the following:

$$\frac{40x + y}{N\,x} = \text{the number of turns of index} \quad \ldots\ldots\ldots\ldots (1)$$

The approximate fraction $\frac{40}{N}$ ..... (2) shows the number of turns of index to use. For $\frac{40}{N}$ we should use a fraction whose denominator is a factor of some index plate at hand. By placing the proper values in formula (1) we may readily obtain the proper gears. I will illustrate by showing how to obtain the necessary gears to cut 113 divisions.

$$\text{Using formula (2)} \quad \frac{40}{113} = \frac{1}{3} \text{ nearly.}$$

$$\text{Using formula (1)} \quad \frac{40\,x + y}{113\,x} = \frac{1}{3}$$

$$\text{Solving,} \quad 3\,y = -7\,x$$

Note that the sign of x is negative. This shows that only one idler is to be used, while if x is positive two must be used.

The ratio of the teeth on the worm gear to the teeth on spindle gear is 3:7

$$\frac{3\,y = -7\,x}{\frac{8}{24 \quad 56}}$$

Use 24 gear on worm, 56 gear on spindle and one idler. Index on 33-hole circle spacing 11 holes or $\frac{11}{33}$ turns. See Fig. 1.

Often two or more sets of gears will cut the same number of divisions, depending on the number of turns of index taken. For example:

$$\frac{40\,x + y}{113\,x} = \frac{4}{11} \quad \ldots\ldots\ldots\ldots (1)$$

$$\text{Solving,} \quad 11\,y = 12\,x$$

The sign of x is positive, therefore use two idlers.

$$\frac{11\,y = 12\,x}{\frac{4}{44 \quad 48}}$$

J. O. Villars was born in Clarksville, Ohio, in 1873. His collegiate education was gained in Wilmington College, Ohio, and Haverford College, Pa. Since that time he has followed the profession of a teacher, having been assistant principal of Wilmington High School, Wilmington, Ohio, for three years, and now fills the position of instructor of physics and applied mechanics at the Williamson Free School of Mechanical Trades, Pa., in which position he has been for the past four and one-half years. In this school about 200 boys are receiving an education to fit them for the various trades of machinist, patternmaker, carpenter, bricklayer, steam or electrical engineer. The work of this school is very practical, the boys being apprentices and doing the work as they would in any well regulated shop. All the graduates are in demand at good wages.

Use 44 worm gear, 48 spindle, two idlers and index plate 33, using $\frac{12}{33}$ turns. See Fig. 2.

Suppose we wish to index 120 divisions, then

$$\frac{40x + y}{120x} = \frac{1}{3} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$3y = 0$$

This shows that with any index circle on which we may get 1-3 turn, we get 120 divisions, by using simple indexing.

Suppose we wish to space ¼ degree or 1,440 divisions,

$$\frac{40}{1440} = \frac{1}{36}$$

but we have no 36 plate. Therefore, use

$$\frac{40x + y}{1440x} = \frac{1}{33}$$

$$11y = 40x$$

Use two idlers compounding on one, with drivers 64 and 60, driven 24 and 44, index plate 33 and 1-33 turn. See Fig. 3.

Suppose we wish to space a vernier to read 5 minutes. By dividing 11 degree spaces into 12 parts we accomplish this. This would give $\frac{4320}{11}$ spaces in the circumference.

$$\frac{40x + y}{\frac{4320}{11}x} = \frac{1}{10} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Solving:

$$11y = -\frac{8x}{4}$$

$$\frac{44}{32}$$

Use 44 worm, 32 spindle, one idler and any index plate upon which 1-10 turn may be obtained. In this case use index plate 20, and 2-20 turn.

I believe this method should commend itself, especially where fractional indexing is needed, and where no table is given for the required number of divisions.

J. O. VILLARS.

Williamson School, Pa.

MAKING PISTON RINGS.

Editor MACHINERY:

Referring to the article in the October, 1903, issue on tools for turning and boring piston rings, written by H. H. Esbenshade, it occurs to me that in his engine he used the one

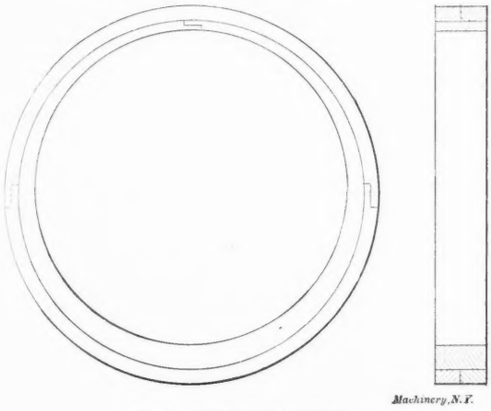


Fig 1. Making Piston Rings.

thickness of ring only, which, of course, is all right for a short-lived engine, but for fear that some one may think it the correct thing, I beg you to give me a hearing. Take for example the experience of the manufacturers of one high-grade engine covering a period of nearly forty-seven years. The conclusion at which they have arrived is that it is strictly right and proper to put in three rings, arranged in the manner shown in Fig 1. The inner one is called the bull-ring, and is about 2 inches wide by ⅜ inch thick at the open side and ⅝ inch or ¾ inch thick at the other. Outside of this ring are the other two lying side by side. These are 1 inch wide by ⅝ inch thick all around. The inside of the bull-ring is not machined, the scale being left on for additional strength, but the outside is turned and finished to diameter size. The outer rings are finishel inside and out and must be parallel both in thickness and in width. Here comes in Mr. Esbenshade's bell chuck and it is certainly first-class. The castings from which the rings are to be made should be bolted into it, and while the tool in the toolpost is turning the outside, they are bored out by an ordinary boring head with follower strung on the mandrel.

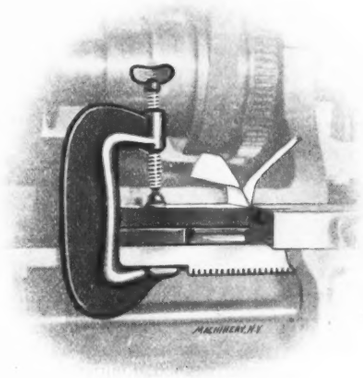


Fig. 2. Iron Clamped on Ways of Lathe to make a Position Stop for Carriage.

When this is all done and we have the exact size both inside and out, the front edge is faced off and we are ready to cut off the first ring. Now as every machine man knows that he cannot depend on a cutting-off tool to do its work exact and straight; it is, therefore, necessary to cut the ring about 1-64 inch wider than the desired finished width. After the first ring has been cut off we then face the front edge again and cut off another, and so continue until the entire blank is used up. After making one hundred or two hundred rings, we are ready to face the rough edge parallel with that already finished. This had always been a very slow operation, it being very diffcult to get them correct and interchangeable for width and at the same time keep the two sides perfectly parallel until the following plan was adopted.

The outer rings were bored and turned and cut rough to length before the bull-ring was made. Then when the bull-ring blank was on the face plate and it had been turned on the outside to fit the bore of the outer rings, and cut into sections up to the butt end of the casting, a section of this butt about ⅞ inch long was turned to a driving fit for the outer rings and the shoulder thus formed faced off perfectly square with a little clearance in the corner. One of the outer rings is then driven on with the finished side snugly against the shoulder, and an ordinary diamond point tool set for a facing cut. When the finishing cut has been taken on this first ring, and before the lathe carriage is moved, a block of iron is clamped on the ways of the lathe "bang up" against the end of the carriage as shown in Fig. 2, thus providing a position stop for the carriage. The carriage may then be run back out of the way, and the finished ring driven off, and another put on in its place. The lathe man then drops two thicknesses of ordinary paper in between the carriage and the stop piece, as shown in Fig. 2, and then takes a cut off the end of the ring. The slips of paper are then removed and with the carriage run close up against the stop, the finishing cut is taken.

HARRY E. WOOD was born in Fulton, N. Y., June 16, 1870. He served an apprenticeship with Frank Dilts, Fulton, N. Y., and has since acquired an extensive experience, having worked for F. W. Wheeler, Bay City, Mich., Industrial Works, Bay City, Mich., Russell & Co., Massillon, Ohio; Oswego Machine Works, Oswego, N. Y.; Ames Iron Works, Oswego, N. Y.; Dexter Folder Co., Pearl River, N. Y.; and others. Mr. Wood is an all-around machinist, tool-maker and designer, and has held the positions of gang boss and foreman. His specialties are steam engine work and paper working machinery. He spent some weeks at the Louisiana Purchase Exposition this summer in charge of an exhibit for the Dexter Folder Co.

Following this method I have faced off sixty-two 14-inch rings in 2¼ hours' time, and at the inspection every one passed O. K. STEEL.

ACCURATE JIG MAKING.

Editor MACHINERY:

The subject of accurate measurements is one that appeals directly to every machinist and toolmaker and upon which two much light cannot be shed. In a large majority of the shops of this country the micrometer and the vernier are the only instruments used in determining whether work is made to the desired dimension, and thus these tools become the arbiters as to the accuracy of any measurements no matter how obtained, whether by screw or gage. Measurements of length and diameter within the limits of these tools are directly attained, but measurements of distance on a plane surface are not so readily found or proved until after the work is done. A method of measuring spaces on a plane surface was described by the writer in the October, 1902, issue of MACHINERY, and it was with the object of calling the attention of your readers to this method and with no desire to criticise the method described by Mr. Frank E. Shailor, in the July issue of MACHINERY that I wrote the letter that appeared in the August issue. I believe I stated that his method is a good one, but that I wished to call attention to mine, which I believe to be better—better because more generally applicable to the average shop. No method, however carefully devised, is of value unless care is taken in using it, and I venture to say ignorance or incompetence will cause errors as gross by one method as by another.

Mr. Shailor has written a letter in which he shows some ten chances for errors that I took in making jigs by the gage method of spacing the distance for bushings. I venture to say he has not read the original article carefully, for if he had he would not have advanced some of the arguments he did.

The first chance for error, according to his letter, was in placing the hole in the bracket central with the drill spindle. This does not appear to me to be a very difficult job, and is one that any good machinist or toolmaker can do without calling very heavily upon his skill. Since Mr. Shailor seems to think it difficult of accomplishment I will briefly state how it may be done: We will suppose all the play of the sleeve in the drill press is taken up and the bracket fastened to the frame of the drill press, then a short, fine-pointed centering drill is put in the chuck, and a center is very slowly and carefully made for the drill; next a short drill is used to drill the hole, which must be somewhat smaller than the bushing to be used. A boring tool is then put in the spindle of the drill press and the hole is bored central with the spindle. If Mr. Shailor will turn to the October, 1902, issue of MACHINERY he will find in my article on jig-making the description of a boring tool that is suitable for the purpose. The hole being bored, a chucking reamer is next run through it, to size it, and it is ready for the bushing.

A second chance for error, he thinks, is in not having the hole in the bushing concentric with the outside. Well, this would apply to the bushings used in any jig, and to me this appears as a trivial objection since Mr. Shailor in his July article gives minute directions for making the bushings for jigs.

The third chance for error is in the fit of the drill and the hole in the bushing; that is, they should fit each other perfectly. There is no doubt about that and it is another mechanical job not very difficult to perform. This is also a condition that must prevail when making any jigs for interchangeable work. It would not seem difficult to make a single bushing to do this when some jigs contain dozens of bushings, each one of which must have its exact size.

The fourth chance is in the fit of the outside diameter of the bushing and the hole in the bracket. This, again, it seems to me, to be trivial since it is a matter that only requires the skill sufficient to find the size of the hole and make the bushing size accordingly; a toolmaker who cannot do this much is not worthy the name.

Fifth, the spindle of the drill press must be at right angles with the table of press in every direction. This is also true of any method of making holes whether upon the drill press or against an angle-plate. No good toolmaker will take anything for granted in the machine line, since he has chips and dirt to look out for in any work he is doing. Any inaccuracy that may exist in this respect is readily found by using a piece of wire as a sweep, and is readily corrected.

The sixth chance for error is put in the form of a question which Mr. Shailor answers to his own satisfaction at least. It is: "What assurance have I that the drill continues straight through the plate?" Answer: "None whatever." Oh! yes I have, I have the assurance that comes from long practice and of doing it repeatedly. Twist drills sometimes run out, as it is called, for several reasons, the first and most common cause being that they are not properly centered and started, the second that they are crowded through the work and caused to deflect by a pressure that buckles them, especially if they are of small diameter. If it were a serious or difficult matter to drill a hole true, even to considerable depths, then I am afraid it would not be of much use to make drill jigs, since they are used solely to guide drills in the work. That it is not so is evidenced by the fact that holes of small diameter and great depth are quite common, such as, for instance, the holes that are drilled in drills having oil feed, gun barrels, etc. A drill that has been started into a piece of work true and to a depth equal to its diameter will continue to run true if it is not crowded and it encounters no variation in density of metal; that is, no holes in the work. Should it do so, however, it gives instant warning of the same by the vibration it causes in the work or the drill itself. Mr. Shailor thinks that sensitive drill presses are more sensitive to spring than any other machine, and for that reason a drill will not continue straight through a piece of work. This is undoubtedly true if sufficient pressure is put upon the drill; it is for that very reason that a small drill is first put through the work which will not require sufficient pressure to spring even a more delicate machine. The greater portion of the pressure comes upon the point of the drill and when the larger drill is used the pressure is thereby eliminated.

The seventh chance for error, he says, is when the holes are opened up with a half-round center reamer having but one cutting point, since cast iron is full of grit and that it requires but a small particle of grit to cause the center reamer to change its location. The statement that cast iron is full of grit is an astonishing one to me. Grit, as I understand the word, is a product of the rocks and stones, and if it were present in any quantity in cast iron but few if any tools could be used upon it. Cast iron, when it comes from the mold, is covered on its surface more or less with the sand from the mold, but this is usually removed by the tumbling barrel or by pickling; in any case such tools as jigs are made of finished castings, and it is only with the interior part of the casting we have to deal. Brown & Sharpe Mfg. Co. in their catalogue give an illustration of a gear tooth cutter that has cut a number of teeth of 4-pitch that is equivalent to cutting a length of 7,472 feet in cast iron. I believe that this particular cutter must have encountered very little grit to have done this amount of work. The object of using a half-round center reamer is that it tends to keep true to the hole it is opening out and it requires not a little effort to cause it to deflect.

The eighth and greatest chance is in opening the holes with a larger drill, the danger coming from having one lip of the drill the least bit longer than the other. This is provided for by the half-round center reamer which opens the mouth of the hole to a diameter equal to the reamer size and therefore larger than the drill. When the drill is entered into the hole it can cut only on the outer edges of the lips since the angle of the center reamer is 60 degrees, while the angle of the lips of the drill (to a transverse plane) is about 30 degrees or less; the drill is therefore entered a considerable distance into the work before the full size chip is taken.

It is my experience that a drill having one lip a little longer than the other will cut somewhat larger than its size, but that it should cause it to run in any direction other than that

of the least resistance is to say the least doubtful. But since this chance seems so objectionable to Mr. Shailor, I call his attention to the fact that the hole can be opened by a counterbore, and as he has said nothing against this way of opening the holes I take it for granted that it is at least feasible in his opinion.

The ninth error is in sizing the hole with a reamer. If the holes were sized with a hand reamer there would be some weight to this objection, as a hand reamer cuts only on the face of the tooth, but the holes should be opened with a machine reamer which, having it start in the hole given it by the center reamer, will follow true, as these reamers cut only on the end and not at all on the sides.

The tenth chance is the personal error in calipering the gages. Personal error, I take it, means the inability to measure twice alike and also the inability of two individuals to attain the same degree of pressure on the measuring instruments. If this condition existed there would be no such a thing as making interchangeable work, since an inch at one time would to the same man be more or less than an inch at some other time, and the product of one workman would not agree

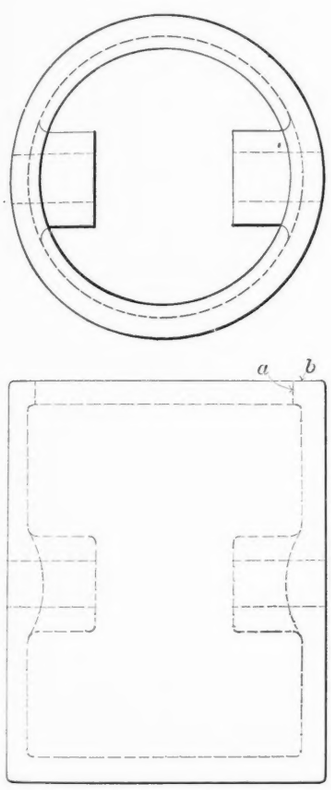


Fig. 1.

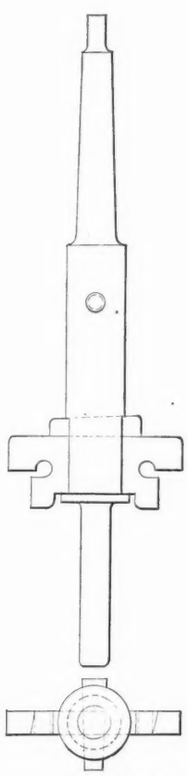


Fig. 5.

with that of another. The facts are that men who have been accustomed to close measurements agree so perfectly with each other that when a question of this kind arises it generally leads to a test of the instruments. It is true that the pressure given the instrument may vary from one man to another slightly, but they in that case vary the initial pressure on their instruments and thus attain the same results. Mr. Shailor seems to think I add one gage on top of another in spacing the distances, but such is not the case. If I wish to move the plate one inch, then the gage would have the length to give the inch of distance required; if I next wished to move the plate one half inch further, then a gage one-half inch longer than the other is used. Errors are not then multiplied, as he seems to think.

His doubts as to whether jigs made by the method I have described could be duplicated amount to nothing, and I will state that they can be exactly duplicated if the same gages are used in both jigs and, moreover, they can be duplicated the same day or ten years hence, which is more than can be said of any milling machine screw that receives anything like the usual service given in most machine shops. J. R. GORDON.

Brooklyn, N. Y.

JIGS AND TOOLS FOR MACHINING SMALL PISTONS.

Editor MACHINERY:

I send herewith drawings of a jig and tools for machining a small piston to prepare it for the turning and grinding. The work is done by a boy on a drill press and by this method he is able to finish three in the same time that it formerly took a man to do one on a lathe. The machining consists of boring and facing one end of the piston approximately true with the inside as shown at *a* and *b*, Fig. 1.

The casting which is shown in Fig. 1 is placed in the jig, Fig. 7, but not at once clamped in place. The jig has been

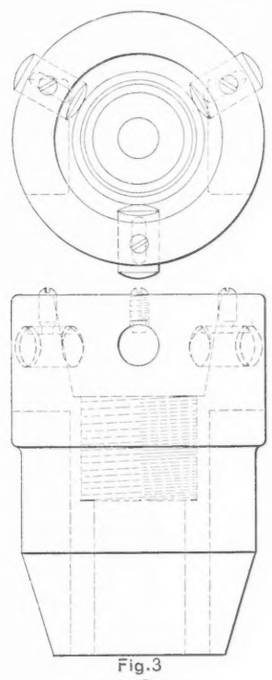


Fig. 3

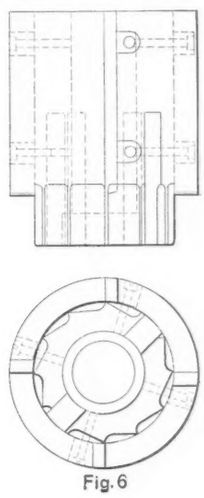


Fig. 6

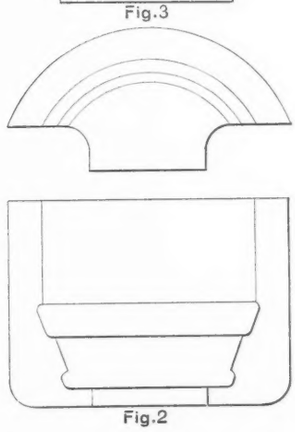


Fig. 2

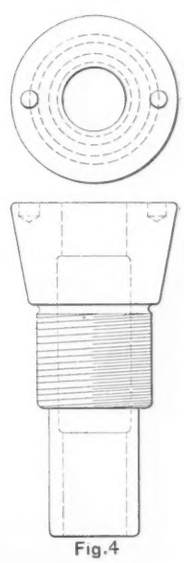


Fig. 4

Industrial Press N.Y.

secured in place on the drill press, in spindle of which are held the boring and facing tools shown in Figs. 5 and 6. Two similar pieces, one of which is shown in Fig. 2, are then dropped to the bottom of the casting and followed by the part, Fig. 3, which, as it goes down, pushes the first two hard against the sides. The part shown in Fig. 4 is then screwed into place, the taper thereon forcing the sliding pins or dogs hard against the sides of the casting. The spindle of the drill press is now lowered until the pilot enters the lower bearing of the bushing, Fig. 4, after which the four setscrews in the sides of the jig, Fig. 7, are brought against the sides of the casting, and the clamp put in place and drawn up tight.

Before the roughing tool, Fig. 5, is placed in the drill press spindle, the finishing tool, Fig. 6, is slipped over its shank, with the lower end of the reamer resting on the roughing

cutters. After the roughing is done, Fig. 6 is turned around until the two slots come over the roughing cutters, when it will drop down until the finishing cutters are below. The taper pin is then put in place to hold it down when the finishing cut is taken.

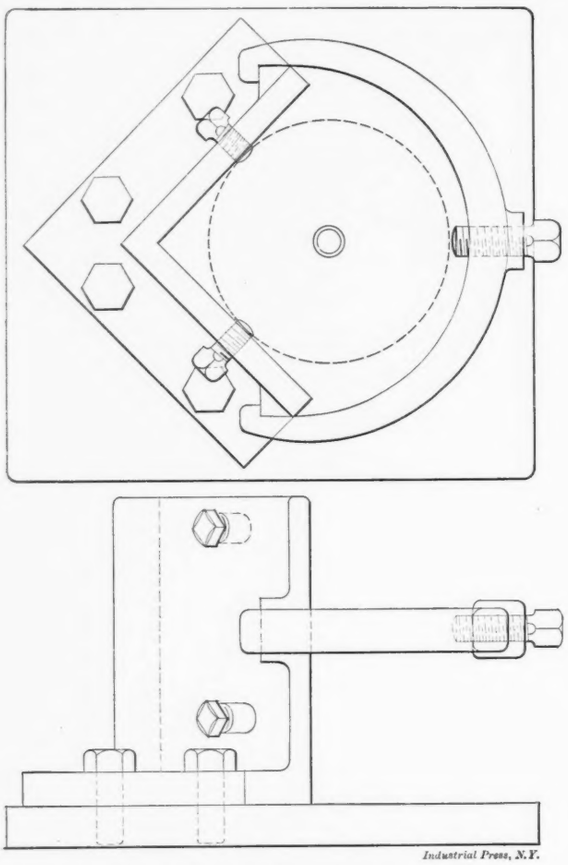


Fig. 7. Jig for Holding Cylinder.

After this operation the wrist pin hole is drilled in a jig, after which it goes to the lathe where it is drawn against a face plate by means of an eye bolt and pin, and is turned and ground in one setting. WILLIAM N. TAYLOR.

MAKING A CORE BOX FROM THE PATTERN.

Editor MACHINERY:

The following method of making a core box for a pattern, after the original core box had been destroyed, was used by

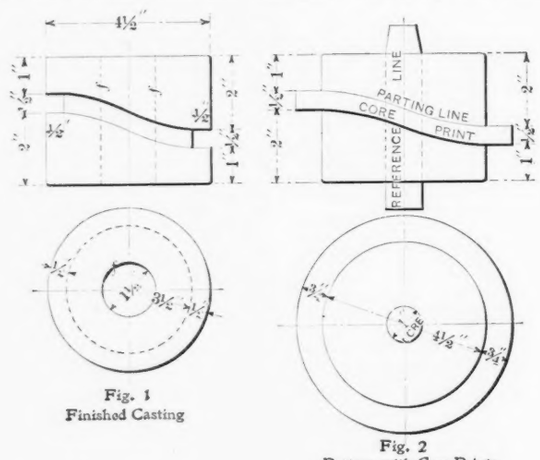


Fig. 1
Finished Casting

Fig. 2
Pattern with Core Prints

Machinery, N.Y.

Making a Core-box from the Pattern.

us and may be of interest to some readers of MACHINERY. Fig. 1 shows the finished casting and Fig. 2 the pattern as sent to us. The pattern was parted along the top of the core print, as shown in Fig. 2.

Three cylinders were turned up as follows: No. 1, Fig. 3, was made 2½ inches long, hollow, with inside diameter of 6 inches, which was the outside diameter of the core print on pattern.

No. 2, Fig. 4, was made 2 inches long, hollow, with inside diameter of 3½ inches, and outside diameter of 6 inches, which were, respectively, the inside and outside diameters of the core to be made:

No. 3, Fig. 5, was made solid, 2½ inches long, with outside diameter of 3½ inches. Reference lines were drawn on the pattern, parallel with axis, as shown in Fig. 2; on the inside of cylinder No. 1; on the outside of cylinder No. 3; and on both sides of cylinder No. 2.

The top of the pattern was taken off and the bottom part put inside cylinder No. 1, with reference line of pattern coinciding with reference line on inside of cylinder and highest part of pattern flush with top of cylinder. A line was then scribed along the inclined surface of pattern on the inside of cylinder, and the pattern was pushed back ½ inch (the thickness of core print) and with reference lines again coinciding, another line was drawn parallel to the first, and ½ inch below. The cylinder was now cut off along the first line drawn. Cylinder No. 2 was then put inside cylinder No. 1, with bottom of No. 2 ½ inch above bottom of No. 1, and with reference lines coinciding. A line was scribed along

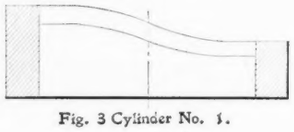


Fig. 3 Cylinder No. 1.

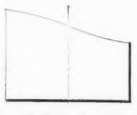


Fig. 5 Cylinder No. 3.

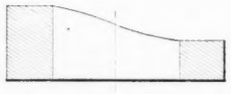


Fig. 4 Cylinder No. 2.

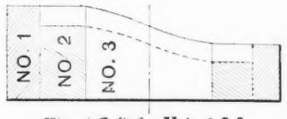


Fig. 6 Cylinder No's 1-2-3 Complete Core Box.

Machinery, N.Y.

Parts of the Core-box.

the inclined surface of cylinder No. 1, on outside surface of No. 2, and cylinder No. 2 was cut off to line scribed. Cylinder No. 3 was put inside No. 2, with bottom of No. 2 ½ inch above bottom of No. 3, and with reference lines coinciding. A line was scribed along inclined surface of cylinder No. 2 on outside surface of No. 3, and cylinder was cut off to this line.

Then cylinder No. 2 was fastened inside No. 1, and cylinder No. 3 was fastened inside of No. 2, with the bottom surfaces all flush, and all reference lines coinciding, this making the complete core box as shown in Fig. 6. Cylinder No. 3 should come flush on top with cylinder No. 1, and cylinder No. 2 should be ½ inch below, and should come even with the second line scribed on cylinder No. 1.

This method does away with making paper templets and obviates mistakes caused by discrepancy in transferring from paper to wood. If the curve is irregular it is just as easy to lay off with this method as if it were a regular curve. We get the exact curve because we scribe our first working line from the pattern itself. JULIAN D. PAGE.

Youngstown, Ohio.

* * *

"CAST IRON SINKS."

A good joke, like the Wandering Jew, can never die. Although it be as ancient and hoary-headed as the everlasting hills, still will it periodically come forth from some unknown hiding place, and gambol before the multitude as nimbly as when the world was young. Who in his youth has not heard of the rustic glaring at the sign: "Cast Iron Sinks" and his scornful comment: "Of course it does, who thought 'twould float," but, like Banquo's ghost, it again walks, and the printed page of a contemporary blazons it forth as a fine sample of original Maine humor to tickle the risibilities of the simple-minded.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

SCREW CUTTING KINK.

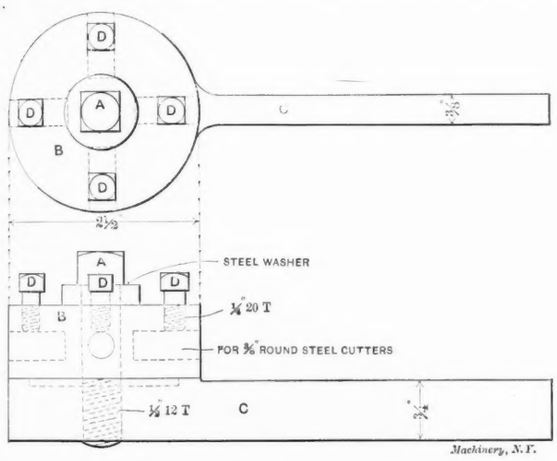
When cutting screws of very quick pitch, or cutting the teeth of spiral gears in a lathe, I place a pulley on the lead screw and lengthen the cone belt so as to drive the lead screw directly from the countershaft, and drive the spindle back through the change gear. By doing this, I am enabled to drive the carriage back and fouth much quicker and with less strain on the lathe. When cutting a quick pitch, more power is generally required to operate the carriage than to drive the spindle.

EUGENE WOPALETZKY.

Trenton, N. J.

TURRET TOOL HOLDER.

The sketch shows a turret toolholder that I use in the toolpost of an engine lathe, and which I find to be a great timesaver on many jobs. The lower or shank part of the tool *C* is a forging with an enlarged end, which is faced, recessed and tapped for the ½-inch clamping screw, *A*. The turret head *B* is turned with a shoulder to fit the recess in the shank *C*, and has four holes drilled in its periphery for the ⅝-inch Jessop steel cutters. The cutters are held with ¼-inch setscrews. On most work the turret head is set so that two tools are used without loosening the clamping screw, *A*, and in some cases three tools may be so used. For instance, suppose we have a facing and turning job on a ring that can



be caught on the outside of the chuck jaws. The right-hand tool is used for facing the side of the ring next the chuck; the front tool for turning the outside; and the left-hand tool for facing the side toward the tailstock. In close quarters, of course, this cannot be done, but where it is necessary to shift the turret it can be done much quicker and with a fraction of the effort required to change a tool held in the toolpost. While the turret has only four holes a mechanic with some ingenuity will often be able to perform five or six operations with them. A gear blank, for example, can be centered, drilled, bored and reamed (a shell reamer being fitted over the boring tool), faced and turned with it. In fact it makes a pretty fair substitute for a turret lathe on many jobs.

New York. L. S. ROSENTHAL.

SHRINKING NUTS OR RINGS FOR PERMANENT SET.

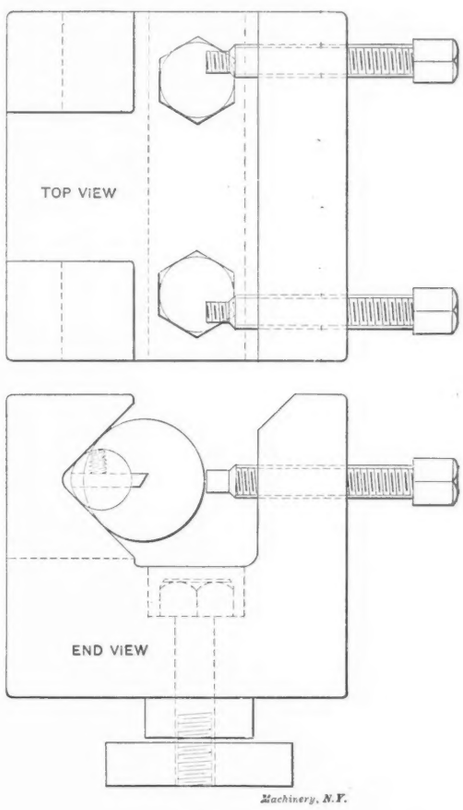
If you should have a nut that requires a snug fit and the tap has cut it too large by three to five thousandths or more, put the nut in the fire, heat it to a bright cherry red, then hold it on a rod and let a stream of water strike it on the outside, keep it turning all the while, cooling off from the outside entirely. Another good way is to heat the nut, the same as before, then hang it on a hook of light wire and immerse one-half of it in the water until cool, then place it back in the fire, heat it as before and cool the other half in the same manner. Be sure to turn the nut half around. Often the nuts fit a little too tight after shrinking, but it is an easy matter to reduce the bolt a few thousandths. In shrinking a ring of about 8 inches diameter made of ⅜ x 1¼-inch flat stock, the diameter can be permanently reduced about ⅛ inch by heating to a glowing red and dipping in the water edgewise to just half the width until cool, then place in the fire, heat, as before, and cool the other half in the same manner. The idea is to shrink one edge and the other will be compressed as long as there is enough heat in it, and so takes a permanent set.

C. D.

Hanover, Pa.

BORING BAR HOLDER.

The accompanying sketches illustrate a boring bar holder in use on a 24-inch lathe. It is made of soft steel, and was casehardened to keep the V-groove from getting bruised. It was made large enough to take in a 3-inch bar. In this holder the boring bars are always at the proper height regardless of their size. No extra bushings are required for smaller bars. A socket for a large size taper shank drill and the necessary reducers are part of the outfit.



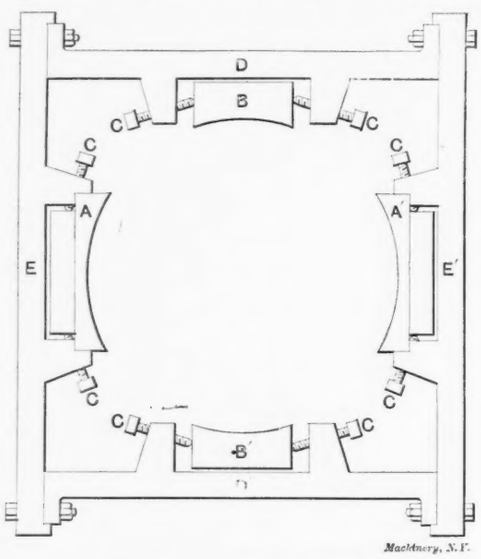
In making this holder the outside was finished, and also the inside, excepting the V. It was then put on the lathe and a light cut taken on both sides of the V, using a bar held in the chuck. Then the V was planed true with the cut, this insuring that the bar would always be held in line with the centers.

H. G.

FIXTURE FOR BORING BRASSES.

The cut shows an efficient and cheaply made jig or fixture for holding the main brasses and quarter brasses of large bearings, for boring. The frame of the jig is composed of four parts, *D D'* and *E E'*, held together at the corners by through bolts. The height of the jig or fixture depends of course upon the length of the brasses to be bored. The reason for making the jig or fixture in four parts, as indicated, was first that the pattern work and molding was cheaper, and second that the jaws for the brasses could be easily planed out, which would not have been the case in this shop if cast solid, since we have no slotter. The plan of the jig is

shown in the cut, and it will be noted that the holding screws *C* are set in an inclined position, thus tending to force the brasses solidly against the outside of the fixture. It was

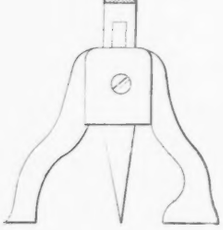


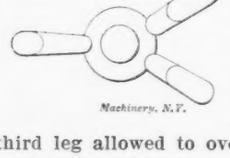
made so that it would take in a variety of sizes, distance pieces being provided to go between the brasses and the frame. It is used on a boring mill and works very well.

PHILADELPHIA.

PRICK PUNCH HOLDER.

The accompanying cut (which is full size) of a prick punch and holder was designed for prick-punching the center mark when laying out work that is afterward to be trued up by this center mark in the lathe by an indicator.





The punch is made an easy but close fit in the holder and is flattened slightly on one side as shown, so that the small setscrew will keep it from coming out of the holder. The point of the punch must be ground true after hardening, otherwise it might draw to one side when struck with the hammer. As the holder rests on three legs there is no tendency to rock, and when the point of the punch rests on the work and is given a light blow, it is sure to go straight down, leaving the center and sides of the hole true. When a center is required that comes close to the edge of the work the two legs with the largest feet may be pressed firmly down to the work and the third leg allowed to overhang while the blow is struck.

Watervliet, N. Y. M. H. BALL.

TOOLS FOR FACING WORK IN THE LATHE.

We all know what a useful tool the half center shown in Fig. 1 is, and we also know that it is a tool rarely found on the various lathes in machine shops, although it is a very annoying proposition to properly face off the ends of shafts, etc., without the proper tools. For this purpose I devised a little contrivance which is a "crackerjack." My first plan was to use the combination drill and countersink (60 degrees) for centering in the usual manner and then re-countersink slightly with a blunter countersink about 90 degrees. Fig. 2 shows how this second countersinking operation made it easy to face down the center. Fig. 3, however, shows my improved method of obtaining the desired result, the small shell end mill *A* being made of drill rod to fit the combination drill and countersink. The teeth are simply filed and the headless screw is pointed and small notches are ground in the body of the countersink which completes the outfit. It will be found extremely useful, and especially desirable is the feature of using this new combination tool for the ends of mandrels, as it sets the center back from the end, thereby protecting same from the hammer blows. Various sizes of shell mills

Fig. 1. Fig. 2.

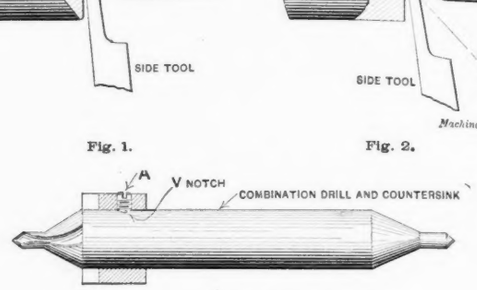


Fig. 3

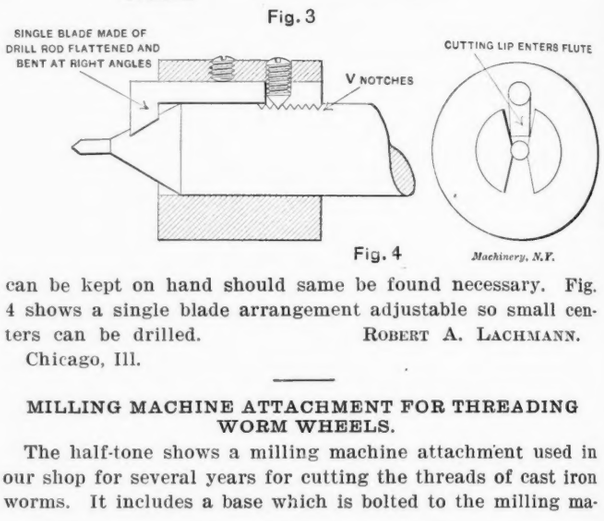


Fig. 4

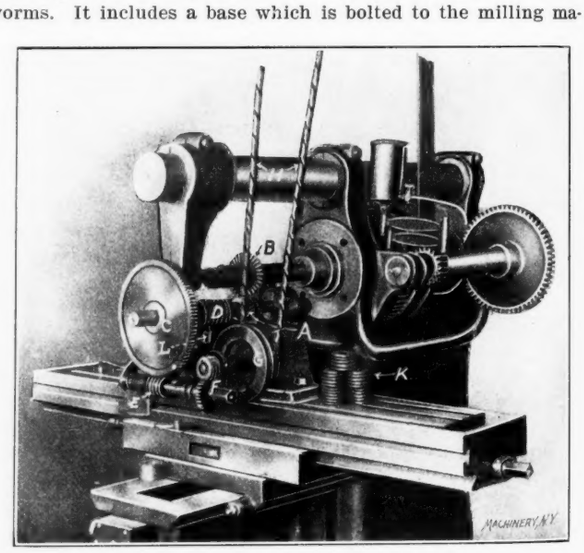
can be kept on hand should same be found necessary. Fig. 4 shows a single blade arrangement adjustable so small centers can be drilled.

ROBERT A. LACHMANN.

Chicago, Ill.

MILLING MACHINE ATTACHMENT FOR THREADING WORM WHEELS.

The half-tone shows a milling machine attachment used in our shop for several years for cutting the threads of cast iron worms. It includes a base which is bolted to the milling ma-



chine platen and provided with bearings for the work arbor and the cone pulley shaft. The worm to be cut is mounted on the arbor and is rotated and moved longitudinally at the same time so as to mill the thread. *A* is the work; *B*, the milling cutter; *C*, a worm wheel; *D*, the lead screw; *L*, a pin having a thin end, which engages the thread of lead screw and acts as a half-nut; *E*, a worm driving wormwheel *C*. It in turn receives its motion from the worm and wormwheel shown at *F*. Power is transmitted to the cone pulley *G*, by the leather belt *H*. The work arbor is splined and is free to

move longitudinally in its bearings, so that as it rotates the lead screw can move it longitudinally as is required to generate the thread. A number of the finished worms are shown on the platen at *K*. PHILADELPHIA.

USING A TAP AS A REAMER.

Having drilled a hole which I was intending to ream out with a 1¼ inch reamer, I found that there was not one of the reamers of that size could be used. So an old tap of the same size was fitted with an extension holder (so it could be held in the drill chuck) and put it in the drill press chuck. Putting on the feed I got as good a hole as I could have gotten with a regulation reamer. Of course the tap could go no faster than the feed was set and consequently the thread cut by one tooth was cut off by the next. ROBERT B. OTIS.

Orange, Mass.

PLANING A CROSS GROOVE.

On one occasion I had to plane a groove in a very large table square across the face. To drive the tool back and forth by hand with the cross-feed is a very tiresome job, so I rigged up means for doing it by power. We had two planers in the shop standing parallel to each other. From planer No. 1 I took out the cross-feed screw, and placed in the end bearing a roller over which a chain was run to a roller in the toolpost of No. 2, then connected to a heavy stud in the platen of planer No. 2. The other end of the chain was secued to the cross slide of planer No. 1 by one of the swiveling screws. Another chain was connected to the opposite side of the cross-slide and run over the roller held in the toolpost in planer No. 2, and thence to the heavy stud. One chain was used to pull the cross-slide back, and the other to pull it ahead. The stroke of the platen of planer No. 2 was set at just the right length, and a helper stopped it at the end of each stroke and exchanged the chains, while I operated the feed on planer No. 1. It was necessary to lift the tool up on every back stroke, as the clapper-box, of course, could not lift to relieve the tool. EUGENE WOPALETZKY.

Trenton, N. J.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

12. C. W. M.—In the directions for turning tapers in the September, 1904, issue, where does "J. T." get the figure 8 which he uses as a multiplier of the distance between the centers; also of the distance to throw the tailstock?

A.—The use of the number 8 as a multiplier is optional, any number could be used instead—or none. The idea is merely to increase the length and amount of taper for convenience in measurement. But both the length and the taper must be multiplied by the same number in order to keep the correct proportion. With the larger dimensions, it is, of course, much easier to get accurate measurements, and that is the only reason for multiplying the given dimensions by *any* number.

13. H. T. S.—I made the lathe roller according to the instructions given by Mr. R. F. Kiefer in the August issue, but find that it works unsatisfactorily. When forced against the work under sufficient pressure to smooth it, the roller ceases revolving and stops. What is the trouble?

A.—The reason the roller refuses to revolve when forced against the work with considerable pressure is undoubtedly because of excessive friction in the bearing. It may be that you did not get the hole through the fork bored square with the sides, in which case the roller may bear hard against one side. In any case the roller should be made with narrow collars projecting above its sides immediately around the bearing. These collars take the side thrust against the sides of the fork and thus reduce the friction from what it would be if the whole side of the roller bore against the fork. To further reduce friction the bolt or pin upon which the roller revolves should be hardened; this also prevents cutting. In general it is best to make lathe rollers for finishing work with a wider bearing than that indicated in Mr. Kiefer's sketch. The best practice is to make the bearing from two to three times the width of the face, thus with a ½-inch face the bearing should be, say 1½ inches long. In some cases the bolt is made of brass or bronze, thus reducing the frictional resistance.

14. Y. E. B.—Will you please explain the method of determining the compression space in a gas engine cylinder so as to obtain any desired amount of compression?

A.—There are two parts to the inside of a gas engine cylinder, one being the compression space and the other the portion traversed by the piston. The latter is equal to the stroke in length, so we will designate it by the term "stroke," while the former we will call the "compression." The sum of these two portions is equal to cylinder volume. See Fig. 1.

Now, if we desire to make our calculations in atmospheres, then the number of atmospheres which we wish the compression to be will represent the total cylinder volume, and one atmosphere will represent the compression space, so we have: Total cylinder volume — 1 = stroke. See Fig. 2.

If we wish to build an engine having a stroke of 12 inches with a compression equal to 4 atmospheres, we would have: Cylinder volume, 4 — 1 (compression) = 3 = stroke. The stroke is 12 inches, so if 3 equals 12 inches, then 1 equals 1-3 of 12, which is 4 inches. Therefore, the compression space should be 4 inches in length.

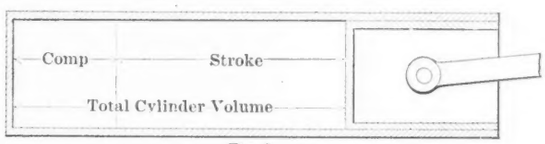


Fig.1

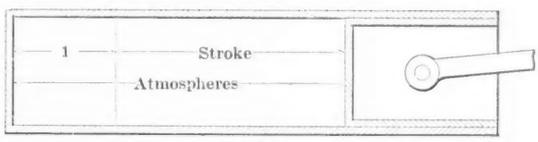


Fig.2

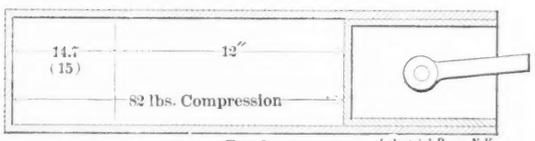


Fig.3 *Industrial Press, N.Y.*

Had we desired to obtain a compression of 4⅛ atmospheres, then 4⅛ = 33-8, so that 33 = cylinder volume and 8 = compression. Then 33 — 8 = 25 = stroke. If the stroke is 12 inches, 8-25 of 12 = 3.84 = compression space. This relation may be expressed by the formula:

$$\frac{\text{stroke}}{\text{atmospheres} - 1} = \text{compression space.}$$

If it is desired to express the compression in pounds rather than atmospheres, then the compression space will be represented by the value of 1 atmosphere in pounds, or 14.7 pounds. The total cylinder volume or length will be represented by the total number of pounds compression to be obtained. In this case we have:

$$\frac{\text{stroke} \times 14.7}{\text{compression} - 14.7} = \text{compression space.}$$ See Fig. 3.

For general purposes, it is sufficiently accurate to consider the value of 1 atmosphere as 15 pounds.

Example: In an engine of 12 inches stroke, it is desired to have a compression of 82 pounds, what will be the length of the compression space?

$$\frac{\text{(stroke) 12-inch} \times 15}{\text{(comp.) 82 lbs.} - 15} = 2.68 \text{ inches} = \text{compression space.}$$

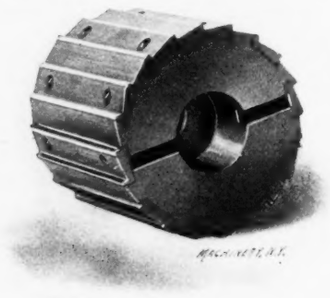
In the foregoing examples, no consideration has been taken of the increase of temperature.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

A "SOLID" ADJUSTABLE REAMER.

One of the late additions to the ever-increasing list of improved tools, and one that has the advantage of having been designed to meet the want which was felt for it in the shop



Gisholt Adjustable Reamer.

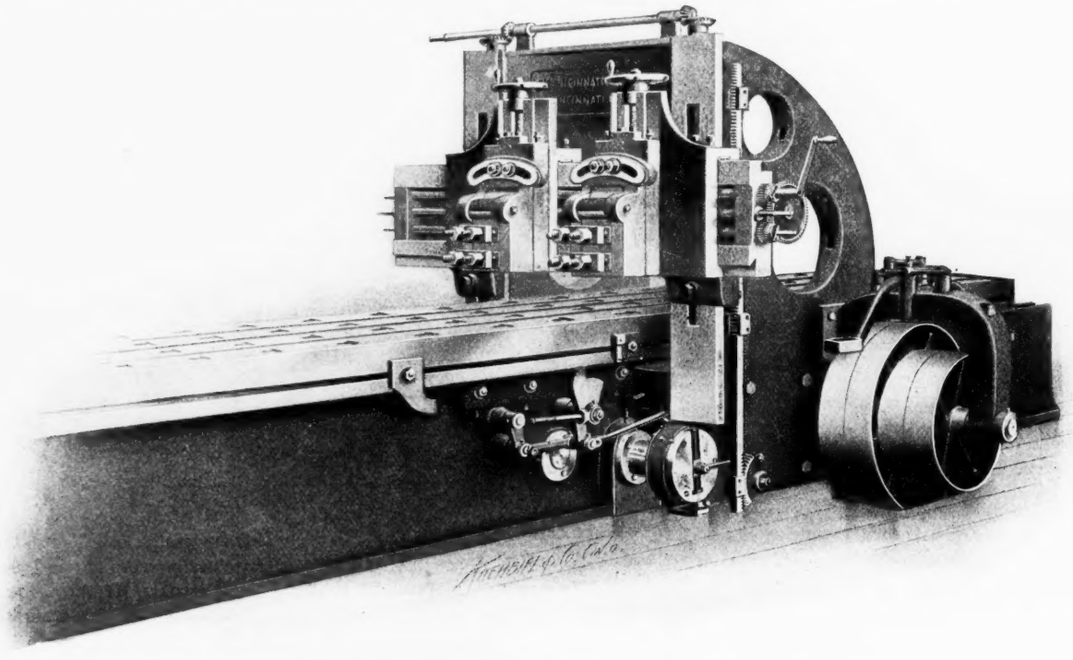
of its builders, the Gisholt Machine Co., is shown in the accompanying illustration. It is an adjustable shell reamer, the principal feature being the extra heavy blades, each having two cutting edges. This gives a simple and strong construction and is a close approach to the solidity of a one-piece tool. The body is made of crucible cast steel, bored and slotted to fit the standard shell reamer arbors. These reamers are manufactured in all standard sizes, both for hand and machine use.

THIRTY-SIX INCH FROG AND SWITCH PLANER.

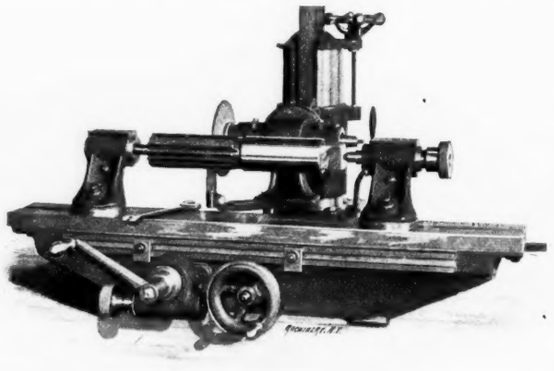
The half-tone above illustrates a 36-inch planer for frog and switch work. In this tool the bed is deep and braced by box girders and four walls have been built between the housings, where there is the greatest strain. Extra wide vees are also provided, which are well lubricated. The table is massive and has an inside bearing on the bed its entire length, overcoming the pressure of heavy side cuts; and to prevent lifting there are adjustable steel gibs on each side. The housings are of box form 10 inches face and extend to the floor. The cross rail is 18 inches wide and strongly braced, making a very rigid construction. The heads have automatic cross and vertical feeds, and are made right and left to bring them close together. There is a safety locking device on the shifting mechanism, and the levers are so arranged that the machine can be operated from either side. The driving shafts are unusually large and run in long bearings fitted solidly into the bed. The rack and gearing are made from solid crucible steel and have been designed to withstand the enormous strain incident to frog and switch work. The countershaft gives two cutting speeds, with a constant return, and is equipped with adjustable ring-oiling hangers. This tool is manufactured by the Cincinnati Planer Co., Cincinnati, O.

WALKER TOOL GRINDER.

We recently illustrated a new cutter and reamer grinder made by the Walker Grinder Co., Worcester, Mass., which has a number of novel features. Among these is the swiveling head attached to an upright column at the rear of the machine, the construction being made possible by the method of belt connection in the Walker type of grinder. The swiveling head construction and belt connection are employed also in the grinder shown herewith. The machine, however, is smaller and less expensive than the one previously illustrated. It is made either as a bench grinder or is mounted on a base, as preferred. The spindle can be used at any angle from horizontal to vertical without altering the belt tension, adapting it to grinding angular mills, backing off reamers, grinding shoulders, the edges of flat pieces, etc. The machine is pro-



Planer for Frog and Switch Work, Cincinnati Planer Company.



Walker Tool Grinder.

vided with an adjustable stop for lever cross feed, the bed is supported on a three-point bearing, the platen is of the T-slot pattern and the center heads are clamped against one side of the T-slot insuring perfect and permanent alignment. All swiveling parts are graduated. An overhanging guard on the rear protects the cross slide. A graduated swivel socket holder, which can also be used as a center, and a tail center block, are provided and, if desired, a vise and other accessories can be supplied.

NEW SENSITIVE DRILL PRESSES.

There has recently been perfected a sensitive drill press for which many advantages are claimed. The inventor of this machine is Mr. Charles D. Rice, superintendent of the

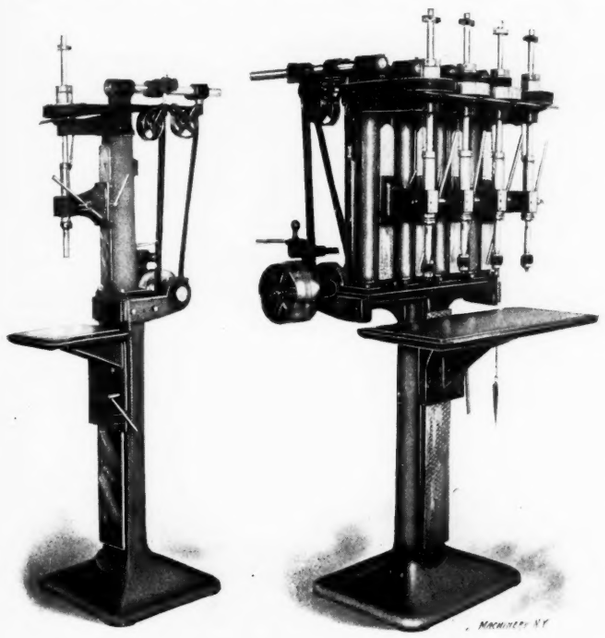


Fig. 1. Drill Presses made by the Henry & Wright Mfg. Co.

Underwood Typewriter Co., Hartford, Conn. Mr. Rice's extended experience in the manufacture of small parts led him to believe that marked improvements were possible with light drilling machines, particularly as regards the high spindle speeds for small drills and the driving efficiency for large ones. This new press is manufactured by the Henry & Wright Mfg. Co., of Hartford, Conn., which company has had designed and constructed a complete outfit of special tools and fixtures for its manufacture in quantity lots and on a strictly interchangeable basis, they having acquired the exclusive right to manufacture for the American trade.

In this drill press the friction is very largely reduced by the use of ball bearings throughout. The spindle is driven by a continuous cemented belt, with means for taking up any slackness and for giving the belt sufficient tension. A new balanced roller key for the spindle drive reduces the friction required in feeding the drill spindle under heavy torsional strains; and the frame is heavier than usual, to secure rigidity. There is also an arrangement whereby four spindle speeds are obtained without adding to the weight of the pulleys. These features have resulted in a greater increase in the amount of work turned out.

Recent tests have shown the following results: A 5-16 drill driven at 1,740 revolutions per minute, drilled through cast iron 1¼ inches thick in 5 seconds, which in one minute would drill through cast iron 15 inches thick. A 7-16 inch drill driven at 780 revolutions per minute, drilled through cast iron 1¼ inches thick in 7 seconds, which in one minute at this speed would drill through cast iron 10 inches thick. A ¾-inch drill at 780 revolutions per minute, drilled through cast iron 1¼ inches thick in 15 seconds, which in one minute at this speed would drill through cast iron 5 inches thick.

These are so unusual that they would seem to a mechanic to be exaggerated, but we are assured that they are actual results that can easily be attained by one of these machines.

It will be observed that the adaptability of the press to drills of from ⅜- to ¾-inch diameter, which heretofore sensitive drill presses have not been able to handle with the economy of heavier machines, makes it available for much of the drilling that has heretofore been done on slower upright geared drill presses.

As stated, the drill presses are equipped throughout with ball bearings, even to the loose pulley used for its driving belt; and the machines run so freely that the same width of belt and size of main driving pulley are used for any number of spindles, from 1 to 6. The same width of belt is used for the main drive as on each drill spindle. The rated power of the driving belt, as given by the makers, for a 6-spindle machine, is but 30 per cent. of that commonly used, yet they state that the drill spindles have fully twice the driving capacity of a machine without the ball bearings, and other features for increasing the efficiency.

Fig. 2 shows details of the driving shaft at the rear of the drill press and indicates the character of the ball bearings on both pulleys and also the method of adjusting the driving pulley on its shaft to enable it to track properly when the belt is changed from one step of the pulley to the other.

A novel idler system has been introduced to make the single endless belt feature feasible. The innermost idler can be adjusted vertically to deliver the belt to either step of the drill spindle cone, while the rear idler has a horizontal adjustment for giving the belt any desired tension.

An interesting feature is the method employed for obtaining four different speeds for the drill spindles and with but two steps to each cone pulley. The plan is to procure the two slowest speeds by allowing the belt to remain on the largest drill spindle pulley step and to shift the rear driving cone pulley lengthwise, introducing either step of the rear driving pulley for action. The two higher speeds are had by dealing with the small step of the drill spindle pulley in a similar manner. It will be noted that when the larger drills are in use only the major diameter of the spindle pulley is used, thereby giving marked driving advantages; also when dealing with smaller drills and which offer less resistance, a very much smaller pulley diameter is used, thereby maintaining a low belt travel as compared with the drill spindle speed, so that

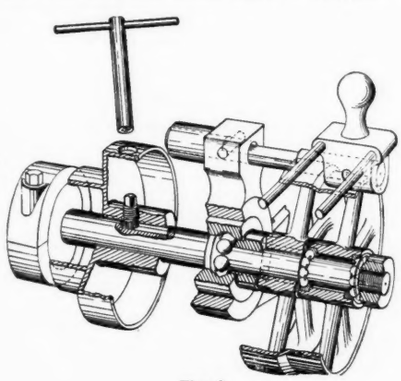


Fig. 2.

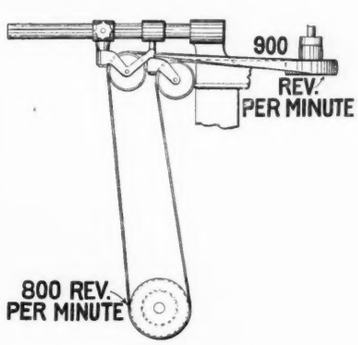


Fig. 3.

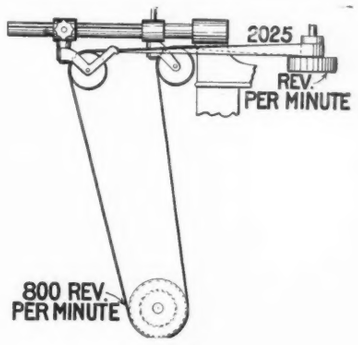


Fig. 4.

with the belt travel advantage, and frictionless journals, very high speeds are possible in every-day practice, which particularly qualifies the tool for the using of drills made of high-speed steel.

In Figs. 3 and 4 the belt is shown in two different positions, for giving spindle speeds respectively of 900 and 2,025 revolutions per minute, with a constant speed of the driving shaft of 800 revolutions per minute. In Fig. 3 the belt is on the large step of the driving pulley and the large step of the spindle pulley, with the idlers arranged accordingly; while in Fig. 4 the belt is still on the large step of the driving pulley but on the small step of the spindle pulley. Similarly by changing to the small step of the driving pulley, two more speeds of 900 and 1,350 revolutions per minute are obtained without changing the speed of the driving shaft. In the large sketch Fig. 5 is a rear view of the machine indicating the method

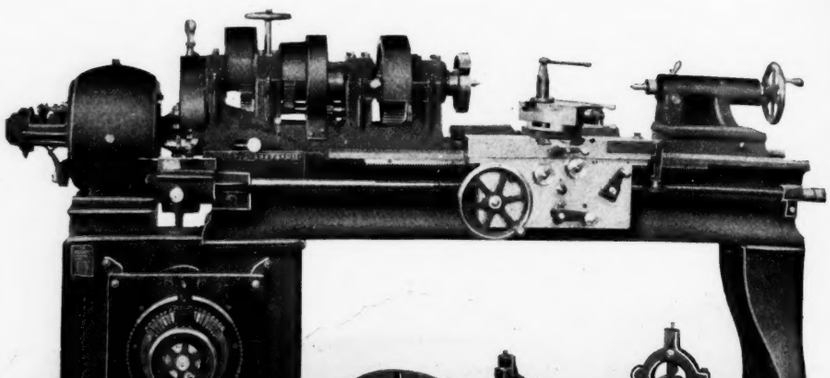


Fig. 1. Lathe Designed especially for Motor Driving.

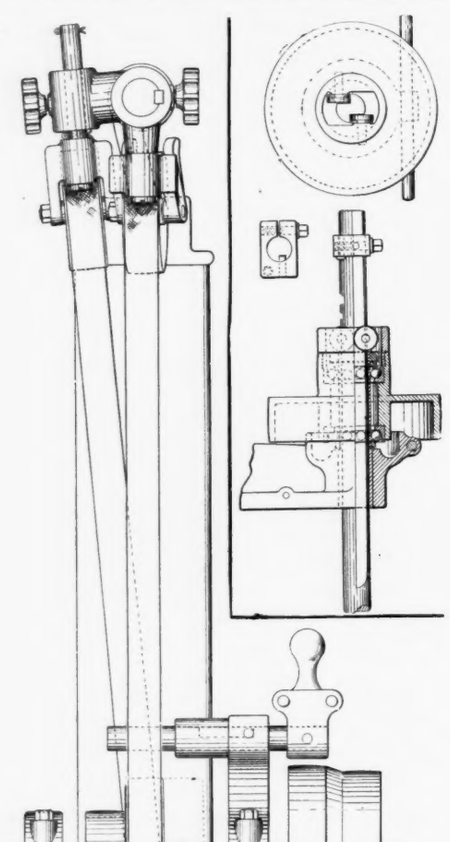


Fig. 5.

of adjusting the idler pulleys to allow the belt to track properly and to take up the slack in the belt.

Another original feature is the use of balanced roller keys, placed diametrally opposite on the drill spindle, for transmitting power between the pulley and the spindle. The object is to overcome the drag due to a plain sliding feather. By using the two balanced keys the spindle is relieved of side thrust in the bearing which supports it within the pulley and by using keys of the roller type, which Mr. Rice has introduced, friction is further eliminated. The small view in Fig. 5 illustrates the balanced roller keys, to take up friction at this point, and also shows the detail of the two-step pulley which drives the spindle. This pulley runs on ball bearings on a sleeve attached to the frame of the drill press, which relieves the spindle entirely from strain due to belt pull.

These drill presses can be used with high-speed steel drills up to the full capacity of the drills, without injury to the press.

LODGE & SHIPLEY LATHE, WITH MOTOR.

The two illustrations herewith are of a motor-driven lathe as now built and equipped by the Lodge & Shipley Machine Tool Co., Cincinnati, O. The motor will give a speed variation of two to one, and the lathe head gives three speed changes which, with the two mechanical changes on the driving shaft, makes six changes obtained in the lathe itself. This

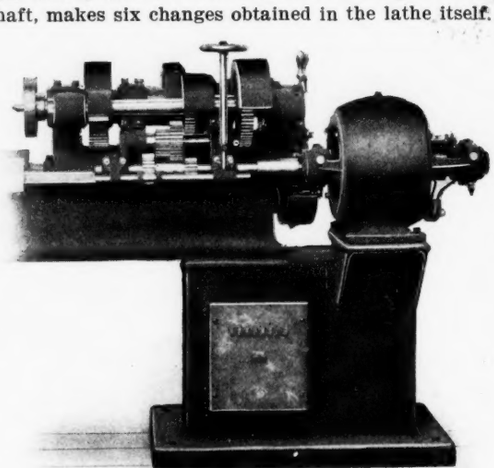


Fig. 2. Rear View of Headstock End.

with the speed variation of the motor, gives a very wide range. The whole arrangement is extremely simple and convenient for the operator. As regularly made, the controller is operated from the carriage and not as shown in the engraving. If desired the lathe can be furnished with a pulley suitably supported in place of the motor, so that the lathe may be operated directly from the line shaft with six changes of spindle speed. The special features to which the builders call attention are the mechanical simplicity of the design and its neatness of appearance. The headstock has all the advantages of the lathe head recently patented by this company, by which high speeds and heavy cuts are easily obtained throughout the whole range of diameters that the lathe can turn without introducing excessive strains or speeds in the bearings or other parts of the headstock mechanism. The illustrations shown in this connection are self-explanatory and need no further description.

NEW AUTOMATIC DRILLING MACHINE.

A year ago we illustrated a rotary-pattern multiple-spindle drill made by the National Automatic Tool Co., Dayton, O., for drilling the small parts of machinery to be manufactured in large quantities. This machine was designed with two groups of spindles, the idea being that if one set of drills was able to handle the drilling, the other set could be used for reaming or tapping; or if the holes were so near together, or there were so many of them that one cluster of spindles could not drill them all, the other group could be called into requisition. Another machine has now been brought out by this company in which this idea is extended so as to include a greater number of combinations, and perform a greater variety of work. The machine has a platen that revolves and carries the jigs with it. The pieces of work are put into and taken out of the jigs by the operator as the table rotates, and one complete rotation of the table completes all the operations to be performed upon a given piece.

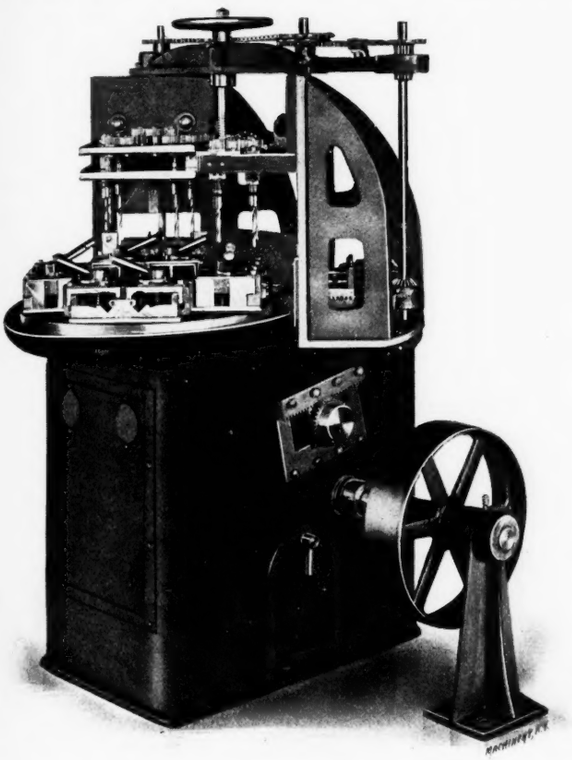


Fig. 1. Automatic Manufacturing Drilling Machine.

The machine has two vertical heads that are adjustable to give variation of depth in the hole drilled. The jigs are attached to the table with a key and dowel so that they can be easily removed and others substituted. The table can be indexed as many times per revolution as the character of the work requires. Among recent orders for this machine were two from a typewriter manufacturer who wished to use it in drilling small drop forgings. Each forging has two drilled holes—one to be reamed and one countersunk. The machine finishes 2,000 of these holes per hour. The jigs furnished for this particular job automatically open and close so that the only duty of the operator is to place the pieces to be drilled in position and remove them.

INTERESTING WORK OF A CIRCULAR SAW.

The universal saw table built by the Colburn Machine Tool Co., Franklin, Pa., of which we have already published a description, apparently has unusual capabilities in the hands of a competent workman, as shown by the samples of work illustrated herewith. This saw bench has all the adjustments of the table and guides that can be applied to such a machine, which enables angular and even circular work to be done to great advantage.

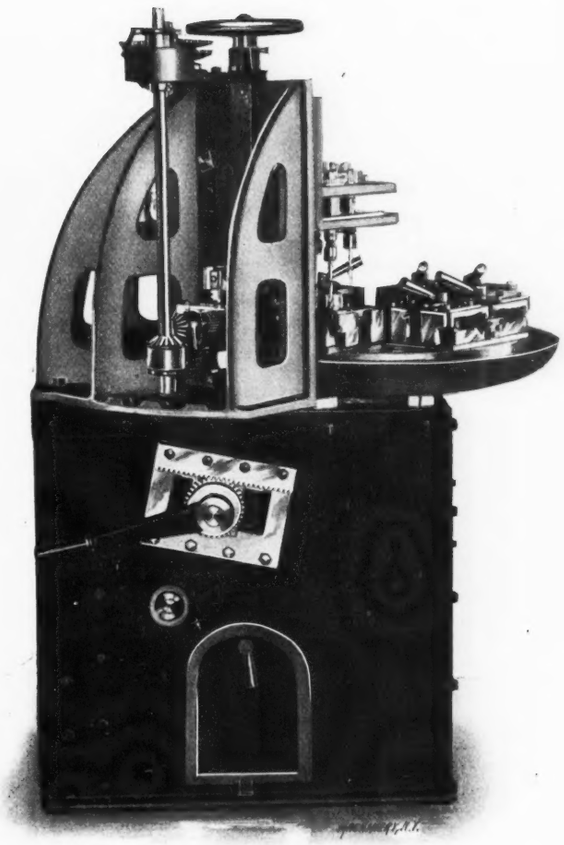


Fig. 2. Automatic Drilling Machine.

In Figs. 1 and 2 herewith are shown four sample boards of pieces all made on the Colburn saw, and are selected from a lot of six similar boards gotten out for the benefit of the agents of this company.

These samples show in a practical manner the great variety of work which can be done on this machine. No attempt has

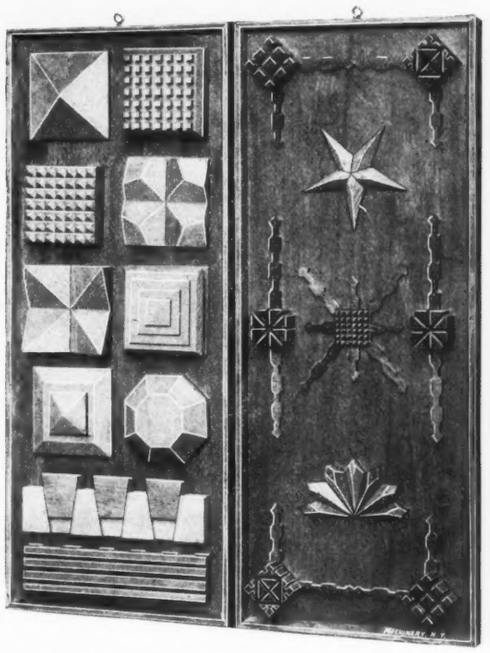


Fig 1. Samples of Work done by Circular Saw.

been made to put a fine finish on the samples, and they are shown just as the saws left them, and in most cases the saw marks are plainly visible. The object in leaving the samples in this manner is to prove beyond any question that they were

actually made with the circular saws, notwithstanding the seeming impossibility of such a performance. While it is true that some of the samples may be curiosities, still nearly all of them represent practical operations and to an ingenious mind suggest innumerable other cuts, all of which can be made on the machine.

Panels Nos. 1 and 2 show a variety of novel and fancy ornaments executed by the saw, which will suggest innumerable possible operations to the ingenious mechanic. Panel 3

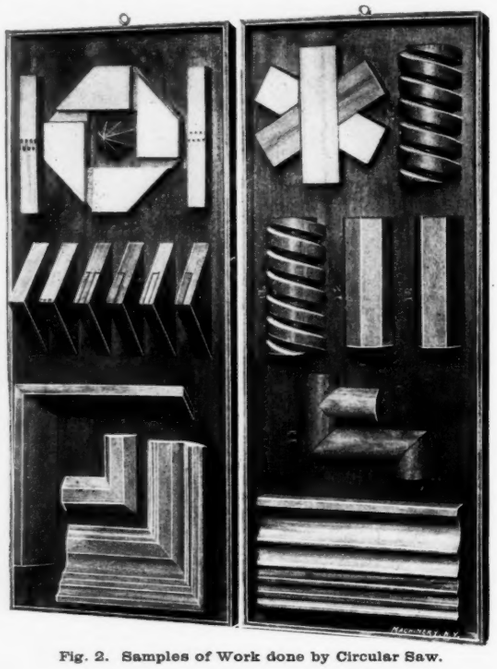


Fig. 2. Samples of Work done by Circular Saw.

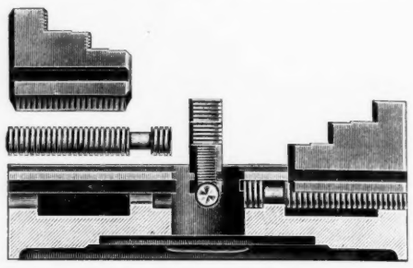
shows samples of moldings having a variety of peculiar cuts, and in the center are six different samples of corner joints. Panel 4 shows, at the bottom, hollow cuts for such work as core boxes, etc., which may be made in sizes up to 4 and 5 inches in diameter. The next piece above illustrates special angular cuts made with the cross-cut saw. Above this are samples of polygonal shapes and samples of jointings; also a wooden screw made for a pattern. A larger illustration of this

Fig. 3. Pattern for Screw Cut by Circular Saw.

screw appears in Fig. 3. This is made by first marking the lead of thread on a round cylinder. The table of the machine is tilted to the proper angle on the thread, and the saw adjusted to cut the depth of thread. The block is then revolved by hand and a little pointer assists the operator in following the markings on the outside. Screws of any diameter and pitch can be cut in this manner.

NEW SKINNER CHUCK.

A new 1904 pattern independent lathe chuck has been brought out by the Skinner Chuck Co., New Britain, Conn., which has several features of interest. The adjusting screws of the jaws are threaded to the periphery of the chuck body so as to permit the holding with safety of larger pieces in a chuck of the corresponding size than in others where the screw is only threaded part of the length and the thrust of the screw taken on the shoulder near the outside of the chuck. The screw has a square hole in the end for receiving a square headed wrench instead of having a square headed screw with the usual style of socket wrench; the advantage of this construction is that the operator can see just how to hold the wrench to enter the socket in the screw, while with the old style socket wrench the nut of the screw is covered and it is always a matter of guess work just how to turn the wrench to have it fit the nut. By taking the thrust on the screw near the inner end of the screw, this strain is brought directly under the face plate to which the screw is attached and is in the

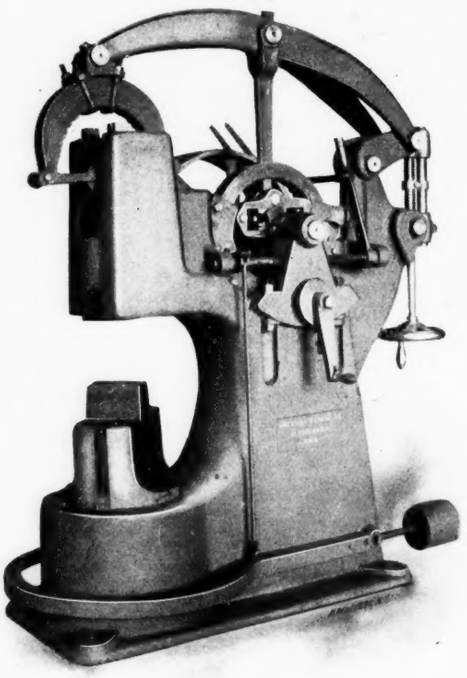


Details of Skinner Chuck.

strongest part of the chuck body. The jaws, which are made of drop forged steel and case hardened in this chuck, are ground on the steps after hardening, insuring the steps being parallel with the face of the chuck. It has been the ordinary practice to grind universal and combination lathe chuck jaws for a long time, but it is a new practice to grind the steps of the jaws on an independent jaw chuck.

THE "THOR" POWER HAMMER.

This hammer is composed as usual of a frame, an anvil, a hammer head, a lever, to which the hammer head is attached by means of the spring, and a crankshaft, acting on the lever. In the plane of the lever, there is supported in the frame, a ring of comparatively large diameter, through which the



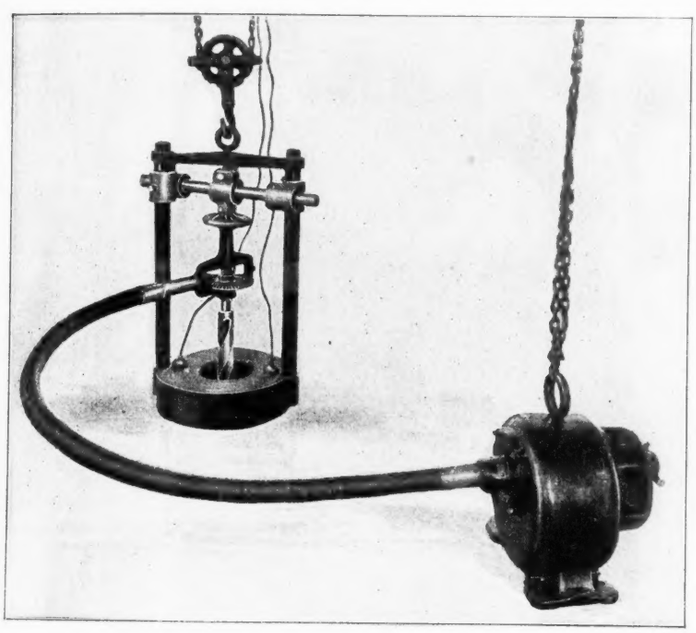
A New Power Hammer.

crankshaft passes. To the ring is jointed an arm, which is connected to the crank of the shaft by being provided with a slot, in which it reciprocates during the rotation of the crank. There is a journal or sliding block on the crank. The arm is oscillated by this movement and is connected to the lever by means of links.

The length of the stroke is adjusted by revolving the ring. If the ring be rotated toward the right, the angle formed between the arm and the perpendicular through the shaft will be decreased. The stroke of the arm and consequently that of the lever and the hammer head, will thus be smaller. When rotating the ring toward the left, the angle mentioned will increase and the stroke of the arm and hammer head will be greater. The ring is rotated by means of the handwheel and screw at the rear.

The advantage of this construction is that the hammer ascends slowly and descends quickly, as the crank at the rotation of the shaft acts on the outer part of the arm when the hammer head ascends, but on the inner part of the arm when the hammer head descends.

It will be evident from the description that this construction gives a means for varying the strength of the blow, and also for adjusting the hammer for different sizes of forgings, while the hammer is running at full power; and these adjustments can be made without danger to the workman. The hammer is therefore applicable for large as well as for small work, and may also be used for drop forging. It is compact and easy to handle. The hammer is made in two sizes, one of which has a weight of drop of 170 pounds and one of 95 pounds. The former will operate successfully upon forgings 6 inches square, and the latter 4 inches square if occasion requires, but for general work the large hammer is recommended for forgings up to 4 inches square and the smaller one up to 3 inches square. The horse power required for the two hammers respectively is 4 and 1.5. The hammer has recently been brought out by the American Machine & Mfg. Co., Cleveland, O.



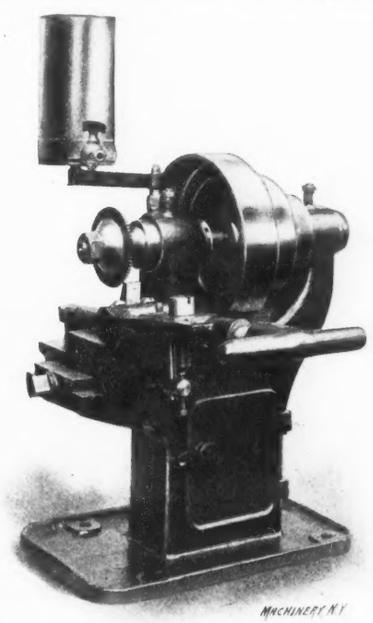
Drilling Device with Magnetic Hold-on.

NOVEL PORTABLE EQUIPMENT.

A neat portable drilling equipment has been brought out by the Coates Clipper Mfg. Co., Worcester, Mass. In this the drill is operated by electric motor through the flexible shaft manufactured by this company, but in addition to the general convenience of a portable drilling device of this description, this tool has the additional one of a magnetic hold-on arrangement which avoids clamping the "old man" to the material to be drilled. This hold-on is built strong enough for drilling a 2-inch hole, and is of especial value to steel plate and armor plate manufacturers. Formerly it was necessary to drill through a hole in the plate in order to fasten the bracket that holds the drill press, or else have the drill press backed up by a sufficient weight to take the thrust of the drill. The magnets used can be quickly attached or detached from the steel plate or casting by simply turning on or off the electric current, and in many classes of work the hole would be drilled while preparations were being made to attach the drilling device.

BENCH SCREW SLOTTER.

The bench screw slotter illustrated herewith has been brought out by the Grant Mfg. & Machine Co., Bridgeport, Conn. In its design the manufacturers have aimed to meet the requirements of the shop having numerous small quantities of special screws, etc., to slot, and its capacity covers a range of screw sizes from the smallest to ½ inch filister head. The smaller ones can be slotted at the rate of 500 per hour. The spindle runs in two tapered self-oiling bronze bearings with adjustments on each to compensate for wear. The carrier slide has a transverse adjustment of ⅞ inch, making it possible to place two cutters on the spindle for milling two sides of a piece at once. The cone pulley has three steps for one-inch belt, and gives ample range of speed for both brass and iron screws. The jaws for holding the work are of one-inch round cold-drawn steel, and are simple and inexpensive to make. Jaws for irregular shapes that may be included in a ½" x ¾-inch space may be used in the machine to advantage. The fulcrum pin on which the carrier holding the jaws swings has large adjustable bearings, and the handle on the jaw clamping screw can be placed in such a position that when the jaws are closed this handle will be parallel with the spindle, the most favorable position for the operator. A stop screw is provided to regulate the depth of slots in screws. The method of operation is simple and rapid. The gripping, slotting, and releasing of the screws are all done with the right hand. The screw to be slotted is inserted between the carrier jaw with the thumb and finger of the right hand and is clamped with the screw shown at the top of the hinged carrier in front of the saw. After slotting the screw, the operator swings the carrier away from the saw, and at the same time releases it by a slight turn of the clamping screw.

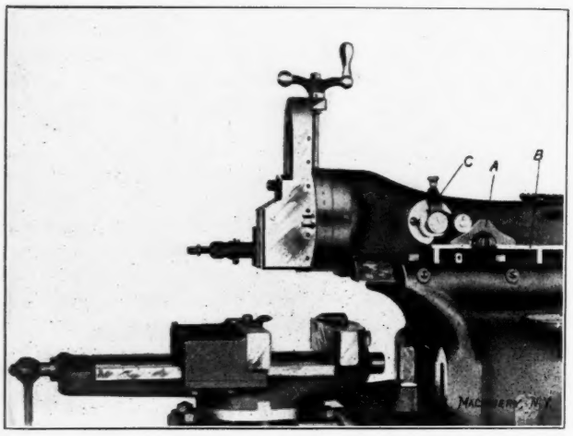


Bench Screw Slotter.

SHAPER ATTACHMENT.

Gould & Eberhardt, Newark, N. J., have recently fitted to their shapers a vertical feed attachment of unusually neat design, which adds materially to the usefulness of this tool as well as to the convenience of the workman. The accompanying half-tone, which shows a shaper equipped with the device, will give a clear idea of the construction of the feed motion. A rail *B* is attached to the top of the frame, alongside of the shaper ram, and a cam-shaped piece, *A*, may be clamped to this rail at any point desired, according to the length and position of the stroke of the shaper. A roll at-

tached to one arm of the bell-crank rides up on this cam at each stroke of the ram, and the other arm of the bell-crank carries a pawl which operates a ratchet wheel attached to the feed mechanism. The distance that the roll rides up on the cam, therefore, determines the number of teeth fed by the pawl at each stroke. It will be seen, therefore, that the cam *A* is the only part that ever needs adjustment, either for varying the amount of feed or to accommodate any change in the stroke of the shaper. A supplemental screw adjustment to the cam is in contemplation, for conveniently varying the feed from 1 to 10 teeth, after the cam is once set.



Vertical Feed Attachment.

PORTABLE "AERIAL GRINDER."

A very handy tool has recently been designed and placed on the market by the Hisey-Wolf Machine Co., Cincinnati, O. It is a "portable aerial surface grinder," electrically driven, and is illustrated herewith.

This grinder was particularly designed for irregular surface grinding, and the cleaning of castings of any kind or shape. It can be suspended anywhere, or counterbalanced from the ceiling or a traveler. The motor is enclosed, and especially built for the work for which it is intended. It has adjustable cone bearings, and detachable handles. The driving power is obtained from the ordinary incandescent lamp socket —direct current only. This machine can be carried to work in any part of the shop, which does away with the handling of heavy castings that require grinding, saving the loss of time and money for re-handling.

Hisey-Wolf Suspended Grinder.

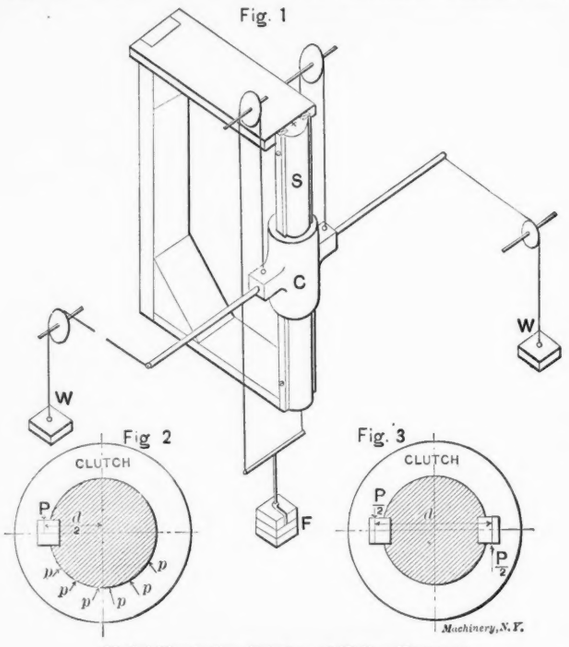
These machines are made in two sizes: ½ and 1 horse power, weighing 40 and 65 pounds, respectively. They are sent out complete, ready for work, as illustrated, with cord, socket and wheel.

* * *

FRICTION OF SLIDING KEYWAYS.

It is generally appreciated that a splined shaft used to transmit motion to a rotary part through which it slides meets with much resistance to sliding motion if the power transmitted is considerable. When the pressure is heavy the frictional resistance may become so great as to break some part taking the longitudinal stress, although apparently amply strong to meet the pressure of ordinary work. Even if breakdowns do not occur the keys or feathers wear out quickly and tend to make the splined shaft, which is an indispensable feature of machine tools and many other machines, a troublesome part. It is not, however, generally known, we believe, that two keyways, on opposite sides of a shaft which is to slide through and transmit rotary motion to a gear or wheel, greatly reduce the frictional resistance to longitudinal motion. A knowledge of this fact would often enable the designer to avoid serious troubles arising from the use of this class of transmitting mechanism.

A British civil engineer, having been called on to investigate and discover the cause for the failure of some large penstock sluice-valves of a dock which were worked by power through large clutches of the claw-tooth type, publishes the result of his investigation in *Engineering*. The clutch which caused the shaft to rotate was provided with only one key and it was suggested that the frictional resistance to longitudinal motion would be reduced by the use of two keys. The suggestion was followed with very successful results. After making the suggestion the engineer rigged up an experimental model, shown diagrammatically herewith, which demonstrated conclusively that where power is transmitted by a splined shaft the resistance to sliding motion is fully two times as great with one key as it is with two keys placed diametrically opposite.



Model illustrating Friction of Sliding Keyways.

In the model the shaft *S*, Fig. 1, was 1½ inches in diameter, with keys in proportion, and was held in a vertical position in a frame, as indicated. One key was fixed in position and the other was movable, but capable of being fixed in place when required by means of countersunk screws. The clutch represented by the cylinder *C* was provided with the necessary keyways, and was capable of sliding along the shaft while subjected to a twisting couple, supplied by means of two equal weights acting upon the ends of the lever arms, through the medium of two pulleys. The weight of *C* was first balanced by means of the strings led vertically up from it and then down over the pulleys to weight *F*. Torsion was then applied to the clutch *C* by the means before described, and the two keys being fixed in position, it was found that a force represented by the weight of 3 pounds was required to just cause *C* to slide up the shaft. One key was then removed, and the force required to just cause *C* to slide was found to be 5 pounds. The result of this experiment showed that the frictional resistance of the clutch to sliding along shaft while transmitting power by means of two keys is only 60 per cent. of that met with when one key only is used. Further experiments confirmed this.